REPORT RESUMES

ED 010 658 08

IDENTIFICATION OF TASK AND KNOWLEDGE CLUSTERS ASSOCIATED WITH PERFORMANCE OF MAJOR TYPES OF BUILDING TRADES WORK, REPORT NUMBER 7.

BY- BAKAMIS, WILLIAM A. AND OTHERS
WASHINGTON STATE UNIV., PULLMAN
REPORT NUMBER ERD-257-65-7 PUB DATE DEC 66
WASHINGTON STATE BOARD FOR VOCAT. EDUC., OLYMPIA
REPORT NUMBER BR-5-0046-7
CONTRACT OEC-5-85-109
EDRS PRICE MF-$0.27 HC-$7.36 184P.

DESCRIPTORS- *VOCATIONAL EDUCATION, *JOB ANALYSIS, JOB SKILLS, *OCCUPATIONAL INFORMATION, *WORK EXPERIENCE, *BUILDING TRADES, TASK PERFORMANCE, BLUE COLLAR OCCUPATIONS, QUESTIONNAIRES, SURVEYS, EMPLOYMENT PATTERNS, JOB TRAINING, PULLMAN, OLYMPIA, WASHINGTON

CLUSTERS OF KNOWLEDGES WIDELY USEFUL TO BUILDING TRADES WORKERS WERE IDENTIFIED. BY QUESTIONNAIRES AND INTERVIEWS, UP-TO-DATE FACTS WERE OBTAINED REGARDING MAJOR TYPES OF TASKS PERFORMED BY A REPRESENTATIVE SAMPLE (229) OF BRICK LAYERS, CARPENTERS, CEMENT FINISHERS, ELECTRICIANS, IRON WORKERS, AND HEATING WORKERS. ON THE BASIS OF THIS INFORMATION, A JURY COMPRISED OF VOCATIONAL TEACHERS, A SCIENTIST, A MATHEMATICIAN, A LANGUAGE ARTS SPECIALIST, AND BUILDING TRADE EMPLOYEES AND SUPERVISORS IDENTIFIED KNOWLEDGES ASSOCIATED WITH THE PERFORMANCE OF MAJOR TASKS. CLUSTERS OF WIDELY USEFUL MATHEMATICS, SCIENCE, AND COMMUNICATION KNOWLEDGES WERE THEN DEFINED. THE AUTHORS ASSUMED THAT ACQUISITION OF SUCH KNOWLEDGES ALONG WITH REQUISITE SKILLS WOULD HELP STUDENTS SUCCEED IN BUILDING TRADE ENTRY JOBS AND SERVE AS BASES FOR RETRAINING, OCCUPATIONAL MOBILITY, AND CAREER-LONG ADVANCEMENT. THIS VOLUME REPRESENTS PART 7 OF THE 13-PART FINAL REPORT ON THE VOCATIONAL-TECHNICAL EDUCATION RESEARCH AND DEVELOPMENT PROJECT OF WASHINGTON STATE UNIVERSITY. RELATED VOLUMES ARE ED 010 652 THROUGH ED 010 664. (JH)

ED010658

FINAL REPORT
Project No. ERD-~~257-65~~ 5-0646
Contract No. OE-5-85-109
Report No. 7

Identification of Task and Knowledge Clusters Associated with Performance of Major Types of Building Trades Work

December 1966

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
This document has been reproduced exactly as received from the person or organization originating it. Points of view or opinions stated do not necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

IDENTIFICATION OF TASK AND KNOWLEDGE CLUSTERS ASSOCIATED WITH PERFORMANCE OF MAJOR TYPES OF BUILDING TRADES WORK

Project No. ERD-257-65
Contract No. OE-5-85-109
Report No. 7

by

William A. Bakamis
Robert E. Kuhl
Edwin K. Hill
Beverly Swarthout
Dale L. Nish

December 1966

The research reported herein was performed pursuant to a contract with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

Department of Education, Washington State University, Pullman, Washington
State Board for Vocational Education, Olympia, Washington

CONTENTS

ACKNOWLEDGMENTS iv

INTRODUCTION

Task and Knowledge Clusters Concepts 1
Purpose and Objectives 2
Background and Rationale 3
Building Trades Education Needs 3
Related Research 3

METHOD

Selection of Building Trades Occupations for Study . 5
Conceptualization and Development of Task Identification Instrument 5
Pilot Testing 6
Sample Design 6
Distribution of Questionnaires 7
Treatment of Questionnaire Response Data 7
Identification of Knowledge and Capability Clusters Associated with Work in Ten Building Trades . . . 11

RESULTS 12

DISCUSSION 17

CONCLUSIONS AND RECOMMENDATIONS 18

SUMMARY 18

REFERENCES 19

APPENDICES

Appendix A, Task Identification Instrument A-1
Appendix B, Percentages of Workers in Each of Ten Building Trades Performing Various Types of Tasks. B-1
Appendix C, Sources of Information Utilized to Conceptualize Task Identification Questionnaire and Knowledge Check List C-1
Appendix D, Knowledges Associated with Work in Ten Building Trades D-1

CONTENTS continued

TABLES

Table 1, Sample Design 8
Table 2, Numbers of Questionnaires Distributed and Per Cents Returned 8
Table 3, Percentages of Workers in Ten Building Trades Performing 30 Similar Tasks 9

CHARTS

Chart 1, Clusters of Knowledge Widely Useful in Ten Building Trades 12

ACKNOWLEDGMENTS

The assistance and encouragement of the State Board for Vocational Education staff and particularly Ernest G. Kramer, Assistant State Superintendent for Vocational Education, and Frank H. Wimer, State Director of Trade and Industrial Education are gratefully acknowledged.

We are grateful to Marilyn May, Ranae Rantanen, and Judith Waddle for careful copy editing and typing.

INTRODUCTION

Task and Knowledge Clusters Concepts

One major purpose of Project ERD-257-65 is to identify clusters of knowledge and competencies most likely to maximize the career-long occupational opportunity, competence, and choice of non-college bound youth in an evolving technological society.

This research is rooted in the philosophic premise that occupational freedom involves both informed choice of alternatives and competence to work effectively. The economy needs constantly larger numbers of workers possessing new capabilities. But youth can evaluate only those occupational choices that they perceive. They are free to perform only the kinds of work for which they acquire competence.

Choice and acquisition of competence may be needlessly impaired by limited outlooks and motivations. For those reasons, studies of occupational perceptions, aspirations constitute other dimensions of this project.

The objective of our clusters research is to obtain facts about what major types of tasks are actually performed in occupations most likely to provide employment opportunity for substantial percentages of non-college bound youth and to identify major types of knowledge most likely to prepare them for such work. On the basis of Bureau of Labor Statistics projections, the following occupational areas were selected for study: office, general merchandise retailing, building trades, electronics, food services, and child care.

To obtain task and knowledge data for clustering, the staff, in consultation with employers, employees, and vocational teachers, prepared questionnaire check lists designed to identify specific major tasks actually performed by workers in each of the occupational areas listed above.

Questionnaires were designed to obtain from employees data on age, sex, major types of tasks presently performed, length of time on present job, and other types of work done in the past five years.

Those questionnaires have been administered to representative samples of workers in each occupational area. To maximize the predictive value of data, questionnaires were administered mainly to employees of modernized leading-edge firms in which the nature of present work is most likely to represent that prevailing in the foreseeable future.

Results provide data on (a) combinations of major tasks workers presently perform, (b) combinations of major tasks performed on entry jobs, (c) combinations of tasks generally performed by workers with various degrees of experience, and (d) some data on five-year combinations of worker experience.

From analysis of the above data, we have obtained up-to-date facts about some combinations of major tasks performed by major categories of workers in entry jobs and in positions representing later-career opportunities.

Knowledge clusters associated with performance of tasks are in various stages of identification by juries of employees, supervisors, and vocational teachers.

Both task and knowledge items are being coded so various patterns of relationships can be identified by computer.

We are identifying (1) some clusters of knowledge useful within each occupational area and (2) some clusters that are commonly useful in two or more areas.

Facts about currently useful tasks and knowledge are being supplemented by studies of ways they will be affected by equipment, processes, and materials now being developed by leading-edge industries.

Purpose and Objectives

This phase of Project ERD-257-65 work represents a comprehensive effort to (a) obtain up-to-date facts about major types of tasks performed by workers in ten major building trades, (b) determine clusters of knowledges and competencies associated with effective performance of work within each trade, and (c) identify clusters of knowledges and competencies common to work in two or more of the trades.

Trades selected for study are:

Bricklaying
Carpentry
Cement finishing
Electrical work
Iron work
Painting
Plastering
Plumbing
Roofing
Sheet metal and heating

These trades do not include all work done in the construction industry. They were selected as subjects for this initial study because such work, as modified by technological developments, is likely to provide income-earning opportunities for substantial percentages of non-college bound youth.

It is assumed that up-to-date facts defining the nature of work in the above building trades and clusters of knowledges and competencies associated with performance of such work will provide schools and community colleges with partial bases for realistic curricula planning.

In cooperation with vocational educators in schools and community colleges, the Project staff plans to use results of this study and related research as bases for development of instructional systems designed to implement up-dated curricula plans. At the discretion of each local school system and each State Department of Vocational Education, such instructional materials can be utilized in a variety of ways for either vocational or general instruction--or both.

Background and Rationale

By 1975 approximately 18 per cent of the nation's labor force will be employed as craftsmen, foremen, and kindred workers. During the next decade, contract construction alone is expected to increase approximately 11 per cent and employ more than three million workers, most of whom will have less than college-level education (3).

Building Trades Education Needs

The nation's capability to pursue its expanding residential, industrial, commercial, and institutional building needs will be influenced by the competencies of building trades workers. Likewise, the income-earning opportunities of over three million men who can be employed in construction work and for other men and women who can perform related sales and office work will be influenced by the adequacy of their training.

Apprenticeship and adult retraining programs will continue to provide substantial amounts of on-the-job training. Likewise, high schools, vocational-technical schools, and community colleges will play major roles in providing youth knowledges and competencies essential for the changing types of entry and later-career building trades work.

Related Research

Employment projections indicate the extent to which adequate preparation for building trades workers will affect both the economy and income-earning opportunities of individuals. "Manpower requirements in contract construction are expected to grow substantially through 1975, rising at a faster rate than the average nonfarm industries.... Large government expenditures for construction of schools, hospitals, and roads, and for urban renewal programs can be anticipated. Construction of industrial plants and commercial establishments, such as office buildings, stores, and banks, is also likely to expand with the general growth of the economy. Projects by the Department of Commerce imply that total new construction activity may increase by about 3/4 between 1964 and 1975. The volume of construction maintenance and repair which now is about 1/3 of new construction is also expected to grow significantly during this period.... On the basis of these and other considerations, manpower requirements in contract construction in 1975 may be as much as well over 1/3 higher than in 1964." (3)

Concern for effective educational means of meeting present and near-future manpower needs has evoked wide-spread thought. Appraising the impact of automation on occupational and vocational education, social scientist Michael observes that: "The problem involves looking ahead five, ten, twenty years to see what are likely to be the occupational and social needs and attitudes of these future periods; planning the intellectual and social education of each age group in the numbers needed, motivating young people to seek...certain types of jobs and to adopt the desirable and necessary attitudes." (2)

After his intensive analysis of current need, veteran vocational educator Venn and his associates substantiate the view that: "High schools should establish vocational education programs which offer all youth leaving high school marketable occupational skills or preparation for further occupational education....

"What is called for is more and better occupational education, to be sure, but occupational education on a more general basis...teaching certain basic skills, of course, but also devoting more time to the development of broader technical understanding of communication and computational abilities and of an appreciation of civic, cultural, and leisure activities."

Venn also concludes that: "Occupational education is the responsibility of every segment of the education system. Each segment of education must provide the kind of occupational education most appropriate to students enrolled at that level of the educational system. No single segment of education can provide the diversity of occupational education needed to meet the wide range of occupations or abilities and aspirations among youth and adults of the nation." (6)

Recognizing facts about the changing nature and interrelationships of many occupations, Wiles, like many other analysts, has observed that: "Seemingly, the wisest step for curriculum planners to take, then, is to study industrial and commercial operations and plan in terms of clusters of competencies. When a student has developed a particular set of abilities, he may enter a variety of related occupations." (7)

Venn's reasoning concurs with that of the H.E.W. Panel of Consultants on Vocational Education which recommended that: "Basic vocational education programs should be designed to provide education in skills and concepts common to clusters of closely related occupations. The curriculum should be derived from analysis of the common features of the occupations included. These students should receive specialized or more advanced vocational training later in post-high school programs, apprenticeship, or on-the-job experience." (5)

For example, in their effort to identify knowledges commonly essential for work in modern electronics, electromechanical, chemical, and electro-chemical occupations Schill and Arnold (4), found that knowledge common to those technologies included technical writing, engineering graphics, mathematics through trigonometry, and the use of test equipment.

A recent analysis of work requirements made as a basis for planning vocational curricula in Pittsburgh, Pennsylvania, led to the conclusion that: "More than 50 per cent of all subject matter necessary to qualify for entry level employment is common throughout all jobs within a family grouping." (1)

METHOD

Selection of Building Trades Occupations for Study

The ten building trades occupations included in this study were selected on the basis that they constitute major sectors of employment in the construction industry.

Conceptualization and Development of Task Identification Instrument

In cooperation with employees, supervisors, and vocational educators, the Project staff developed the task identification questionnaires. Numerous job analyses, on-the-job training programs, text books, building codes, and courses of study were utilized for preliminary conceptualization of tasks. A total of 118 courses of study, training, manuals, and technical publications utilized in this process are listed in Appendix C. These preliminary concepts were modified by extensive analytical interview-reviews with workers, foremen, and vocational educators. The questionnaires and published materials used for conceptualization are reproduced in Appendix A.

Growing bodies of evidence indicate that existing classifications of building trades work do not correspond with the actual tasks performed by various categories of workers. For example, on modern construction jobs "carpenters" commonly use torches to weld metal studding to metal bases embedded in concrete floors.

Considerable evidence also indicates that at various points in their careers increasing numbers of building trades workers perform tasks traditionally classified in more than one of the ten categories included in this study. For example, at various times during their careers, or during a single month or year, many individuals actually do work usually classified as carpentry, metal work, or plastering. Such cross-overs are frequent on residential and other types of small-scale construction jobs. They are increasingly fostered by development of new materials and processes.

For those reasons, the instrument was originally designed to obtain information showing the extent individual workers actually perform tasks commonly classified in more than one of the ten occupations included in the study.

Pilot Testing

The original questionnaires were pilot tested by administering them to at least two workers in each of the ten occupational categories. On the basis of responses and interviews, vague wording of some items was identified. Wording of those items was revised. Pilot testing also indicated that some items could be eliminated.

Sample Design

A sample of building trades workers which would yield data for each trade in proportion to its percentage of workers in the total of all ten trades was designed. The design was constructed to sample a statistically acceptable and economically feasible total number of workers. When these subjects were distributed proportionally among the trades, some trades included more subjects than it was practical to contact and some included fewer subjects than was statistically acceptable. Table I shows that the sample design called for 200 subjects in the Carpentry category. It was not feasible to contact this many subjects. Likewise, the Plastering category called for five subjects, a sample size not statistically acceptable. To compensate for the discrepancies between the theoretical design and the realistic situation, adjustments were made in the sample size of the very large and very small categories. For example, the theoretical design called for only five plasterers, but 16 were querried as the minimum acceptable sample size for any single trade. The alteration of sample size in some trades and not others caused the adjusted sample design to have some categories which were not proportional representations of the percentage of workers in those trades. To compensate for those adjustments, weighting factors were calculated to make the categories in the adjusted sample design proportional to the actual percentage of workers in those categories. The weighting factor for each category was the ratio of the number of subjects in the original sample to the number of subjects in the adjusted sample. For example, in the Plastering category the weighting factor was 5/16 = 31. When the weighting factors are applied to the adjusted sample design, the results are equivalent to those that would be obtained by use of the theoretical sample. Table I shows the theoretical sample design, the adjusted sample design, and the weighting factor for each trade.

Distribution of Questionnaires

General plans for administering questionnaires were made in cooperation with Executive Secretary of the Washington State Building Trades Council and county or regional Executive Secretaries serving populous areas of Washington and Idaho. Next, the staff met with Executive Secretaries and Business Agents of each trade union to agree on ways of distributing questionnaires to individuals representing categories as required by the sample design. Business Agents distributed and collected all questionnaires.

A total of 361 questionnaires were distributed; 229 were returned. See Table 2.

Treatment of Questionnaire Response Data

The percentages of workers in each of the ten building trades reporting performance of various tasks were computed. Results are shown in Appendix B.

Table 1

SAMPLE DESIGN

Craft	Original Sample Design	Adjusted Sample Design	Weighting Factor*
Bricklaying	16	22	.73
Carpentry	200	117	1.71
Cement Finishing	14	22	.64
Electrical	32	32	1.00
Iron Working	12	18	.67
Paint	49	49	1.00
Plaster	5	16	.31
Plumbing	39	39	1.00
Roofing	5	16	.31
Sheet Metal	22	30	.73

$$\text{* Weighting Factor} = \frac{\text{number in original sample design category}}{\text{number in adjusted sample design category}}$$

Table 2

NUMBERS OF QUESTIONNAIRES DISTRIBUTED AND PER CENTS RETURNED

Craft	Number Distributed	Number Returned	Per Cent Returned
Bricklaying	22	16	72.7
Carpentry	117	77	65.8
Cement Finishing	22	10	45.4
Electrical	32	32	100.0
Iron Working	18	9	50.0
Painting	49	18	36.7
Plastering	16	15	93.7
Plumbing	39	11	28.2
Roofing	16	16	100.0
Sheet Metal (Heating & Air Conditioning)	30	25	83.3
TOTAL	361	229	67.6

Table 3

PERCENTAGES OF WORKERS IN TEN BUILDING TRADES PERFORMING 30 SIMILAR TASKS

(Percentages rounded to nearest whole number)

	Bricklayers and masons	Carpenters	Cement workers	Electrical workers	Iron workers	Painters and paper hangers	Plasterers	Plumbers	Roofers	Sheet metal, heating, and air conditioning workers
Lay out and install girders, beams, supports, braces		54		24	100			75		13
Construct or erect scaffolding	22	98	60	68	100	98	91	100	100	63
Rig and hoist materials	73	83	52	69	100	75	80	100	100	52
Spot weld metal studding and other structural members		61		29	50			50		58
Cut metal to size by use of cutting torches		34		32	89			100		56
Weld sheet metal materials and objects		18		27	67			44		63
Weld with oxy-acetylene		24		39	57			78		35
Weld with electric arc		26		38	78			77		52
Weld with resistance welding equipment		9		88	33			14		19
Weld with heliarc		7		4	25			14		33
Inspect and test welds		7		7	57			29		30
Braze and solder structural members		12		19	59			56		54
Lay out and weld pipe		5		4	53			67		35
Weld hard surfaced heat treated materials and objects		11		4	29			29		10
Use handbooks, manuals, catalogues	46	9	57	94	75	60	21	100	69	78
Estimate time needed for a job	92	69	59	77	89	88	80	64	94	84

	Brick layers and masons	Carpenters	Cement workers	Electrical workers	Iron workers	Painters and paper hangers	Plasterers	Plumbers	Roofers	Sheet metal, heating, and air conditioning workers
Estimate amounts of materials needed	91	74	72	80	75	82	83	91	93	75
Estimate work force needed for a job	73	67	74	70	89	72	82	60	94	61
Develop specifications and schedules	40	34	43	28	43	29	36	62	36	26
Assemble information: facts, ideas	72	70	89	90	88	86	70	100	82	77
Read blue prints	88	97	100	97	100	63	89	100	71	91
Draw or sketch plans	33	59	29	61	67	38	0	78	33	71
Write work and supply orders	46	48	10	40	75	47	22	78	31	45
Receive written instructions	92	83	67	84	100	100	30	82	80	87
Discuss work with associates	100	100	100	100	100	100	100	100	100	100
Receive and interpret oral instructions	100	100	100	100	100	100	100	100	100	100
Outline and organize facts for oral or written presentation	73	70	89	90	89	86	70	100	82	77
Prepare charts, graphs, illustrations	10	33	0	40	50	29	11	75	30	29
Make written reports	10	31	29	41	75	33	20	62	27	9
Use communication equipment: telephone, teletype	60	73	44	84	75	69	75	56	67	79

Table 3 continued.

Table 3 was derived from the data in Appendix B. The Table indicates degrees to which 30 work functions are common to all ten trades. Evidence that these thirty work functions have substantial degrees of commonality should not be interpreted to mean that they are the only ones commonly performed by large percentages of workers in the ten trades. They are presented here only as some which have been identified so far. Others probably can be identified by different conceptualization of tasks.

Identification of Knowledge and Capability Clusters Associated with Work in Ten Building Trades

A team composed of three vocational educators, a physical scientist, a mathematician, a language arts teacher, workers, and foremen utilized 118 courses of study training manuals, and technical publications to conceptualize a check list of knowledges hypothestically associated with task performance. Their sources are listed in Appendix C. Mathematical and electrical knowledges were arranged in orders consistent with recent thought respecting knowledge structures most likely to maximize students' comprehensions.

That check list was used as a basis for interviews with at least two workers in each of the ten occupational categories. In each case, in-depth interviews of four to four and one-half hours duration were conducted by a jury of vocational educators and specialists in mathematics, science, and language and graphic arts. All interviews were tape recorded.

On the basis of those interviews, jury members used the knowledge check list to record their joint judgement about the relationship between a knowledge and performance of tasks constituting major percentages of work done by people in each trade.

Knowledges deemed to be directly involved in performance of work were conceived as "operational" and given a value of five. Knowledges not directly operational, but enabling a person to better relate his work to that done by others were conceived as "related general knowledges" and given a value of three. Example: for a carpenter, knowledge of framing methods is "operational." Because he uses that knowledge directly in the specific tasks he performs, it is valued at five. While general knowledges of electrical wiring, plumbing, and heat ducts are not required to perform specific framing tasks, those knowledges do help a carpenter frame more intelligently and efficiently. Such knowledges are valued three. Knowledges deemed neither directly or indirectly associated with performance of work are valued zero.

RESULTS

The items on the knowledge check list and the jury's quantitative judgment of their usefulness and shown in Appendix D.

From analysis of data in Appendix D and responses of workers who were interviewed, the jury and staff have conceptualized seven knowledge clusters useful to all, or most, workers in the ten building trades. Those clusters are:

Construction Types, Methods, and Materials
Tools and Machines
Mathematics
Science
Communication
Safety
Worker Welfare

Knowledges within each cluster are shown on Chart 1. Information obtained from interviews had substantial bearing on determination of some items within clusters.

Chart 1

CLUSTERS OF KNOWLEDGE WIDELY USEFUL IN TEN BUILDING TRADES

Construction Types, Methods, and Materials

Frame construction: types, methods, materials
Masonry construction: types, methods, materials
Reinforced concrete construction: types, methods, materials
Anchor bolt installation
Plumbing: types, methods, materials
Heating and air conditioning: types, methods, materials
Simple circuit wiring, including temporary construction wiring
Oxy-acetylene welding methods and materials
Electric arc welding methods and materials
Oxy-acetylene cutting methods and materials
American Welding Society numbering system

Table 1 continued

Tools and Machines

Air compressors
Boring tools, wood; hand drills, reamers, braces, etc.
Boring tools, metal
Caulking tools
Concrete and mortar mixing hand tools
Drills, power: portable and stationary
Electrician hand tools: pliers, side cutters, etc.
Fastening tools: hammers, screwdrivers, staplers, etc.
Holding tools: "C" clamps, bar clamps, vises, etc.
Layout, measuring, marking and checking instruments (woodworking)
Motors, gasoline
Painting and finishing equipment: brushes, rollers, etc.
Power actuated tools
Prying tools
Saws, portable, stationary
Scraping tools; hand and power
Sharp-edge cutting tools; hand: chisels, star drills, countersinks, knives, etc.
Spray gun equipment
Tooth cutting tools, wood
Tooth cutting tools, metal
Tool sharpening equipment
Torches, gas: cutting, welding
Welders, electric: AC and DC

Mathematics

Methods of mental mathematical approximations
Unit conversion
Linear measurement
Methods of calculating areas of rectangular figures
Methods of calculating areas of figures containing circles
Arithmetic of the integers
Order properties of the integers
Concept of ratio and proportion
Arithmetic operations with fractions
Concept of lines and planes
Arithmetic operations with decimals
Conversion: fraction--decimal
Time calculation concepts
Interpolation
Concept of per cent
Order properties of fractions and decimals
Concept of congruence
Concept of symmetry

Chart 1 continued

Science

- Principles of simple machines, pulleys, levers, wheels
- Principles of mechanical advantage, pivots, angles, inclined planes
- Electricity: circuits, conductors, insulators, voltage, resistance, wiring diagrams
- Principles of heat transfer, expansion, and contraction
- Principles of pressure
- Acids, bases, salts
- Temperatures

Physical Properties of Building Materials

- Acoustic
- Adhesives
- Abrasives
- Agregates: sand, gravel, crushed rock, etc.
- Asbestos
- Caulking
- Conductors; heat, electric
- Doors and door frames
- Fasteners: nails, screws, bolts, staples, etc.
- Glass and glazing supplies
- Insulation
- Lumber and wood products
- Mortar ingredients
- Metals: sheet, plate, extruded, angle, etc.
- Paints and finishes, including cleaning materials
- Reinforcing materials: mesh, rods, ties, etc.
- Water-proofing materials
- Glass

Communication

- Building construction vocabulary
- Blueprints: views, scales, dimensions, symbols, and conventions, elevations, sections
- General specifications and schedules: sheet metal, plumbing, electrical, concrete, masonry
- Standard symbols and signals
- Sources of facts and ideas: handbooks, manuals, catalogues, journals
- Listening to and interpreting priorities and sequences in oral suggestions and directions
- Reading and interpreting priorities and sequences in written suggestions and directions

Chart 1 continued

Communication continued

- Oral and written presentation of suggestions, instructions, and reports
  - Methods of identifying and assembling facts and ideas
  - Methods of appraising relevance, priorities, and relationships of facts and ideas
  - Methods of arranging facts and ideas in logical, functional sequence: outlining
  - Direct subject-predicate sentences
  - Topic sentences as contexts for paragraphs
  - Graphics: diagrams, charts, graphs, photographs, orthographic and isometric sketching techniques

Worker Welfare

- Workmen compensation
- Health and welfare laws and agreements
- Social security and pensions
- Taxes, deductions
- Vacations and holidays
- Apprenticeship contracts and standards
- Labor management contracts
- Seniority and job advancement

Safety

- Occupational hazards and diseases
- Lifting heavy objects
- Protection of eyes
- Protection against dust, fumes, gases
- Handling of materials: lumber, metal, etc.
- Work clothes
- Protection of eyes and person
- Poisons, solids, liquids, and vapors
- Chemical safety

* * * * * *

Analyses made so far also indicate that more specialized knowledge clusters particularly useful to workers in two or more of the ten trades can be conceptualized and identified.

For example, examination of data in Appendix D indicates especially close congruence of knowledges associated with tasks performed by bricklayers, carpenters, iron workers, and sheet metal workers. The data indicate similarly close congruence of knowledges used by workers in sheet metal, plumbing, electrical, and brick laying trades.

The Project staff plans analysis that will more precisely identify such clusters.

At this point, however, analysis of data in Appendix D permits the following general observations.

Many knowledges required for carpentry are similar to those required for sheet metal, plumbing, electrical, and brick laying work.

A general knowledge of electrical wiring is utilized by carpenters, iron workers, and sheet metal workers.

Knowledges required for iron and reinforced concrete work are useful to carpenters, plumbers, electricians, and sheet metal workers.

Knowledges required for painting are also useful to carpenters, electricians, cement finishers, plumbers, and roofers.

Knowledges associated with roofing are also associated with sheet metal, iron, and plumbing work.

Knowledges required for plastering are closely related to those useful for brick laying, painting, and cement finishing.

Mathematical and physical science knowledges widely useful in all building trades are shown on Chart 1.

Welding knowledges are widely used by electricians, iron workers, roofers, carpenters, and brick layers.

Knowledge of metal properties is closely associated with work in all ten trades except plastering.

Knowledge of materials, fixtures, and fasteners is useful in all trades, especially electrical, iron working, plumbing, sheet metal, and carpentry.

Clearly, ability to read blueprints enlarges the capability of workers in all trades, especially carpenters, iron workers, plumbers, electricians, sheet metal workers, and brick layers.

Oral, written, and graphic communication capabilities are closely associated with work in all trades, especially carpentry, electrical work, iron work, plumbing, sheet metal, and brick laying.

Knowledge of use and care of tools and equipment used for work is an essential in all trades.

DISCUSSION

Obviously, the validity of the knowledge clusters reported above is limited by the judgment of the teams and respondents who identified their relationships to task performance. However, until some more precise measure of relationships is developed, that limitation is inherent in any effort to define useful knowledge clusters.

Within those limits, the authors believe that the clusters derived from this study provide a partial base for planning curricula likely to help pupils acquire knowledge most useful for work in the building trades. The clusters can be used as partial bases for instruction in either general or vocational courses.

Curricula planners and teachers need awareness that the clusters derived from this study represent knowledge associated with tasks presently performed by building trades workers. Considerable evidence indicates that those tasks are rapidly being modified by development of new materials and processes.

New plastic and metal alloy materials constantly modify the nature of building construction tasks. Likewise, swift developments in prefabrication of prefinished wood, plastic, plaster, metal, and pre-stressed concrete units continually change tasks, tools, and skills presently utilized.

For those reasons, the Project staff is presently interviewing research and development personnel in major corporations to obtain estimates of how new materials, equipment, and processes now in conceptual and/or developmental stages can be expected to change building trades work and the knowledges necessary to do it.

Information obtained by this study, and related ones, clearly indicate that in the near future craftsmen are likely to comprise smaller percentages of work crews and that larger percentages are likely to be comprised of supervisory, administrative, and office personnel.

To the degrees that the above observations are correct, educators have need to keep currently informed about the changing nature of the specific skills and knowledges actually involved in modern construction work. They have equal obligation to help pupils acquire clusters of skills, knowledge, and general competence that so obviously provide essential bases for occupational flexibility, mobility, and career-long advancement.

CONCLUSIONS AND RECOMMENDATIONS

The clusters of knowledges shown in Chart 1 are widely useful for major tasks presently performed in major sectors of the construction industry. Along with provision of requisite skills, those knowledges represent partial but essential bases for work in entry jobs. They also serve to enlarge pupils' capacity for retraining, for occupational mobility, and for occupational advancement.

For those reasons, local and state curriculum planners and teachers have reason and obligation to consider systematic means of acquainting pupils likely to pursue building trades occupations with such knowledge.

As a next stage of work, Project ERD-257-65 staff members plan development and experimental use of instructional systems designed to help pupils with varying capabilities and backgrounds acquire such knowledge.

SUMMARY

The purpose of this project was to identify clusters of knowledges widely useful to building trades workers. By questionnaires and interviews, up-to-date facts were obtained regarding major types of tasks performed by a representative sample of brick layers, carpenters, cement finishers, electricians, iron workers, painters, plasterers, plumbers, sheet metal workers, and heating workers. On the bases of that information, a jury comprised of vocational teachers, a scientist, a mathematician, language arts specialist, employees, and supervisors identified knowledges associated with performance of major tasks. From interpretation of that data, clusters of widely useful mathematics, science, and communication knowledges were defined. It is assumed that, along with requisite skills, acquisition of such knowledges will help pupils succeed in entry jobs and serve as bases for retraining, occupational mobility, and career-long advancement.

REFERENCES

1. Dauwalder, Donald D., Vocational Education in the Pittsburgh Public Schools. Pittsburgh: The Pittsburgh Board of Public Education, April 1963.

2. Michael, Donald N., Cybernation: The Silent Conquest. Santa Barbara, Calif.: Center for the Study of Democratic Institutions, 1962.

3. Manpower Report of the President and A Report on Manpower Requirements, Resources, Utilization, and Training by the United States Department of Labor, Transmitted to the Congress, March 1965. Washington, D.C.: Government Printing Office, 1965.

4. Schill, William J., and Joseph P. Arnold, Curricula Content for Six Technologies. Urbana, Illinois: Bureau of Educational Research and the Department of Vocational and Technical Education, University of Illinois, 1965.

5. U. S. Department of Health, Education, and Welfare, Office of Education, Education for a Changing World of Work: Report of the Panel of Consultants on Vocational Education. OE-80021. Washington, D.C.: Government Printing Office, 1963.

6. Venn, Grant, Man, Education, and Work. Washington, D.C.: American Council on Education, 1965.

7. Wiles, Kimball, The Changing Curriculum of the American High School. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1963.

APPENDIX A

The following four pages, designed to solicit cooperation and to obtain facts about relevant variables preceeded each questionnaire.

You can help our schools give your sons and daughters the kind of education they need to earn good incomes.

As you know, many changes are taking place in the kinds of work people do. Schools need up-to-date facts about exactly what kinds of work are being done. Those facts will help schools provide useful training.

You have been selected to help with a nation-wide study to show what actual kinds of work people in various occupations do.

The information will be STRICTLY CONFIDENTIAL.

Your cooperation is appreciated and will help your schools prepare young people to earn good incomes.

After you have completed the attached questionnaire, return it promptly in the enclosed self-addressed envelope. No postage is necessary.

This Project is sponsored by:

Washington State University
University of Idaho
Washington State Board for Vocational Education
Idaho State Board for Vocational Education

In questions 1 - 4, please fill in the blank with the necessary information.

1. Name ____

2. Present Job Title ________________________________

3. Name of Employing Firm ____________________________

4. Address of Employing Firm __________________________

In question 5 check (x) all the answers that apply to you.

5. Where did you receive your specialized occupational training?
   - ____ 1. On the job (not apprentice)
   - ____ 2. Apprentice
   - ____ 3. Military
   - ____ 4. Business College
   - ____ 5. Trade or technical school
   - ____ 6. Correspondence
   - ____ 7. Specialized school (for example: IBM Key Punch School, Heavy Equipment School)
   - ____ 8. High school
   - ____ 9. Junior college
   - ____ 10. Self taught
   - ____ 11. Other (please list)

     ____
     ____
     ____
     ____
     ____

In questions 6 - 10, please circle the one answer which applies.

6. What was the highest grade of school you completed?
   8 or less, 9, 10, 11, 12, 13, 14, 15, 16, or more

7. Sex? Male Female

8. Age
   Under 20 20-30 31-50 Over 50

9. For how many years have you been in your present occupation?
   Less than 1 year 1-5 years More than 5 years

10. How many times have you changed occupations in the past 5 years? (For example: plumber to sheet metal worker to retail sales = 2 changes)
    0 times
    1 - 2 times
    3 or more times

11. Please check (x) the types of construction jobs you have worked on during the past two years:

_____ Residential (homes - single or double unit dwelling)
_____ Industrial (factories, warehouses, etc.)
_____ Commercial (stores, motels, apartment houses, etc.)
_____ Institutional (hospitals, schools, etc.)
_____ Other (list): ____________________________________

12. Do you have any supervisory (foremanship) responsibilities?

_____ Yes _____ No

13. If you answered "yes" to the above question, check the portions of your time used for supervisory work?

_____ full time
_____ three fourths
_____ one half
_____ one fourth
_____ less than one fourth

14. If you do supervisory work, check the numbers or workers you supervise.

_____ less than 5
_____ 5 - 10
_____ 11 - 15
_____ more than 16

INSTRUCTIONS

On the following pages is a list of tasks.

Read each task listed.

If you have actually performed the task during the past two years, check (x) the blank under "YES" which appears to the left of the item.

If you have not performed the task in the last two years, check (x) the blank under "NO" to the left of the item.

DO NOT CHECK "YES" UNLESS YOU HAVE ACTUALLY PERFORMED THIS TASK IN THE LAST TWO (2) YEARS.

MAKE CERTAIN THAT YOU CHECK EACH ITEM EITHER "YES" OR "NO."

These examples may be helpful to you:

YES	NO	
x		Built forms (A check of "yes" indicates you have built forms as part of your occupation in the past two years.)
	x	Drive a truck (A check of "no" indicates you have not driven a truck as part of your occupation in the past two years.)

MASONS' AND BRICKLAYERS' QUESTIONNAIRE

If you have performed a task on your job in the past two years check (x) YES. If not (x) NO. Please check all items either YES or NO.

YES	NO	
___	___	Layed out and installed masonry and stone veneer walls
___	___	Cut masonry units
___	___	Set bearing plates for beams into masonry
___	___	Installed pre-cast masonry units
___	___	Layed out, installed, and finished steps, floors, walks, etc.
___	___	Layed out and installed facing tile (exterior and interior)
___	___	Painted concrete surfaces
___	___	Sandblasted exterior walls
___	___	Applied terrazo
___	___	Installed fire brick and refractory brick lining
___	___	Installed tilt-up masonry slabs
___	___	Mixed and tempered mortar
___	___	Layed out and installed solid or cavity masonry walls (interior or exterior)
___	___	Layed out and installed fireplaces, chimneys
___	___	Applied waterproofing to masonry surfaces
___	___	Washed pointed, and caulked masonry work
___	___	Repaired and maintained masonry structures
___	___	Ground and polished stone slabs

Please list any other types of masonry and bricklaying tasks you have performed in the last two years:

____

____

____

____

Miscellaneous Activities

YES	NO	
___	___	Rigged and hoisted materials
___	___	Constructed or erected scaffolding
___	___	Drew, sketched plans
___	___	Estimated materials needed for a job
___	___	Gave written instructions

___ ___ Received oral instructions
___ ___ Outlined facts in clear, logical order
___ ___ Used handbooks, manuals, catalogues, etc.
___ ___ Prepared technical reports in writing
___ ___ Developed specifications and schedules
___ ___ Operated lifting devices: cranes, winch, block and tackle, chain hoist, etc.
___ ___ Read blue prints
___ ___ Estimated time needed to do a job
___ ___ Estimated work force needed to complete a job
___ ___ Gave oral instructions
___ ___ Collected information, obtained facts and ideas
___ ___ Prepared charts, graphs, and pictures
___ ___ Used communication equipment: telephone, teletype, etc.

Please list any other major types of miscellaneous tasks you have performed in the last two years:

____
____
____
____

CARPENTERS' QUESTIONNAIRE

If you have performed a task on your job in the past two years check (x) YES. If not (x) NO. Please check all items either YES or NO.

YES NO

___ ___ Layed out building
___ ___ Excavated for footings, foundation, etc.
___ ___ Constructed runways, ramps, etc., for transporting concrete
___ ___ Stripped forms
___ ___ Layed out and framed roofs
___ ___ Fabricated light roof trusses
___ ___ Applied wood shingles and composition roof covering
___ ___ Built entrances and porches
___ ___ Hung window sash
___ ___ Installed wall boards
___ ___ Applied door trim
___ ___ Applied ceiling tile and trim
___ ___ Installed baseboards
___ ___ Applied wall panels (plywood, masonite, etc.)

___ ___ Installed kitchen cabinets
___ ___ Installed newel posts and hand rails
___ ___ Installed floors, (asbestos, asphalt, vinyl, tile, linoleum, etc.)
___ ___ Constructed with heavy timbers (including laminated beams)
___ ___ Fabricated cabinets and mill work
___ ___ Constructed window and sash
___ ___ Fabricated interior jambs and linear trim
___ ___ Primed (painted) base coat on wood materials
___ ___ Applied metal finishes
___ ___ Fabricated paneling (mill work)
___ ___ Altered and repaired existing structures
___ ___ Determined soil conditions and drainage
___ ___ Layed out and constructed concrete forms
___ ___ Framed sills, girders, joists, subfloors
___ ___ Framed sidewalls; interior walls, applied sheathing
___ ___ Installed window and door frames
___ ___ Applied side wall covering
___ ___ Installed cornices
___ ___ Applied lath and plaster bases
___ ___ Installed door and window jambs
___ ___ Installed linen closets
___ ___ Installed stairs (finished)
___ ___ Installed floors (wood)
___ ___ Hung doors, exterior and interior
___ ___ Installed hardward (hinges, catches, locks, etc.)
___ ___ Installed piles and pile foundations
___ ___ Built towers and bridges
___ ___ Constructed exterior door and window frames
___ ___ Fabricated cabinets and cases
___ ___ Applied varnish, paint, etc. (finish or final coat)
___ ___ Fabricated cabinet and built-in stock (mill work)
___ ___ Fabricated stairwork (mill work)

Please list any other major types of carpentry tasks you have performed in the last two years:

____
____
____
____

YES NO

___ ___ Layed out and installed girders, beams, supports, braces, etc. on the job or at the shop (plant)
___ ___ Spot welded metal studding and other structural members on the job or at the shop (plant)

___ ___ Cut metal to specified size using acetylene and/or carbon and steel electrode arc method
___ ___ Welded sheet-metal objects made of such metals as aluminum, brass, iron and steel, or of such alloys as dural, monel, and stainless steel
___ ___ Welded with oxy-acetylene
___ ___ Welded with electric arc
___ ___ Welded with resistance welding method
___ ___ Welded with heliarc
___ ___ Inspected and tested welds
___ ___ Brazed and soldered structural members
___ ___ Layed out and welded pipe
___ ___ Hard surfaced and heat-treated metalic objects

Please list any other major types of welding tasks you have performed in the past two years:

____
____
____

Miscellaneous Activities

YES NO

___ ___ Rigged and hoisted materials
___ ___ Constructed or erected scaffolding
___ ___ Drew, sketched plans
___ ___ Estimated materials needed for a job
___ ___ Gave written instructions
___ ___ Received written instructions
___ ___ Received oral instructions
___ ___ Outlined facts in clear, logical order
___ ___ Used handbooks, manuals, catalogues, etc.
___ ___ Prepared technical reports in writing
___ ___ Developed specifications and schedules
___ ___ Operated lifting devices: cranes, winch, block and tackle, chain hoist, etc.
___ ___ Read blue prints
___ ___ Estimated time needed to do a job
___ ___ Estimated work force needed to complete a job
___ ___ Gave oral instructions
___ ___ Collected information, obtained facts and ideas
___ ___ Prepared charts, graphs, and pictures
___ ___ Used communication equipment: telephone, teletype, etc.

Please list any other major types of miscellaneous tasks you have performed in the last two years:

____
____
____

CONCRETE WORKERS' QUESTIONNAIRE

If you have performed a task on your job in the past two years check (x) YES. If not (x) NO. Please check all items either YES or NO.

YES	NO	
___	___	Mixed concrete on the job
___	___	Transported concrete (plant to job site)
___	___	Prepared and finished thin shell concrete
___	___	Prepared and finished concrete floors, walls, etc., in multilevel building
___	___	Prepared and finished concrete on water resource projects (small dams, irrigation ditches, storage tanks)
___	___	Prepared and finished concrete paving, walks, curbs
___	___	Prepared concrete mix at plant
___	___	Sampled and tested concrete
___	___	Prepared and finished concrete floors, walls, etc., in residential homes
___	___	Operated power vibrators
___	___	Finished air-entrained concrete
___	___	Prepared and finished concrete project on farms
___	___	Prepared and applied shotcrete

Please list any other major types of concrete tasks you have performed in the last two years:

Miscellaneous Activities

YES	NO	
___	___	Rigged and hoisted materials
___	___	Constructed or erected scaffolding
___	___	Drew, sketched plans
___	___	Estimated materials needed for a job
___	___	Gave written instructions
___	___	Received written instructions
___	___	Received oral instructions
___	___	Outlined facts in clear, logical order
___	___	Used handbooks, manuals, catalogues, etc.
___	___	Prepared technical reports in writing
___	___	Developed specifications and schedules

___ ___ Operated lifting devices: cranes, winch, block and tackle, chain hoist, etc.
___ ___ Read blue prints
___ ___ Estimated time needed to do a job
___ ___ Estimated work force needed to complete a job
___ ___ Gave oral instructions
___ ___ Collected information, obtained facts and ideas
___ ___ Prepared charts, graphs, and pictures
___ ___ Used communication equipment: telephone, teletype, etc.

Please list any other major types of miscellaneous tasks you have performed in the last two years:

____
____
____
____

ELECTRICAL WORKERS' QUESTIONNAIRE

If you have performed a task on your job in the past two years check (x) YES. If not (x) NO. Please check all items either YES or NO.

YES NO

___ ___ Designed circuit, conduit, or duct layouts for residential, commercial, or industrial buildings
___ ___ Wired in raceways
___ ___ Installed temporary construction wiring
___ ___ Installed, connected or repaired: single or multi-phase distribution transformers
___ ___ Installed openwiring
___ ___ Layed out, installed or maintained: DC or single and multiphased AC, branch or feeder circuits
___ ___ Layed out or installed: electrical/electronic signal systems (P.A., telephone, radio, T.V.)
___ ___ Installed switches and outlets
___ ___ Installed equipment and appliances
___ ___ Layed out, assembled or installed: electrical/electronic signs and controls
___ ___ Diagnosed trouble, adjusted or serviced: electrical/electronic motor and equipment controls (Manual, semi-automatic or automatic) and/or instruments
___ ___ Installed or repaired: DC, single or multi-phase AC motors, generators and controls

___ ___ Rewound DC, single or multiphase AC motors, generators or transformers

___ ___ Operated plant: including reading of load graphs and power surveys; maintaining voltage regulation; inspection of circuit breaker systems, etc.

___ ___ Installed interior industrial power systems: (steam plants, hydraulic plants, diesel plants, gas turbine plants and atomic plants)

___ ___ Installed cable wiring

___ ___ Installed underground/underwater wiring

___ ___ Installed surface wiring

___ ___ Layed out, installed and/or repaired single, multiphased AC service and metering equipment

___ ___ Installed or serviced: DC or single and multiphase AC power distribution control equipment

___ ___ Installed overhead services

___ ___ Installed underground services

___ ___ Installed high voltage services (2,300 volts and above)

___ ___ Designed, layed out, installed, or serviced: residential commercial, or industrial, interior/exterior lighting systems

___ ___ Designed, layed out or installed: electrical heating systems and controls

___ ___ Diagnosed trouble, serviced or repaired: electronic communications equipment

___ ___ Diagnosed trouble, serviced or repaired: electrical appliances, power tools (portable and stationary)

___ ___ Layed out and installed: X-Ray, radio/TV transmitter or hazardous location wiring systems

___ ___ Installed or maintained: power station or transmission line power distribution equipment (exterior)

Please list any other major types of electrical tasks you have performed in the last two years:

____

____

____

____

YES NO

___ ___ Layed out and installed girders, beams, supports, braces, etc. on the job or at the shop (plant)

___ ___ Spot welded metal studding and other structural members on the job or at the shop (plant)

___ ___ Cut metal to specified size using acetylene and/or carbon and steel electrode arc method

___ ___ Welded sheet-metal objects made of such metals as aluminum, brass, iron and steel, or of such alloys as dural, monel, and stainless steel
___ ___ Welded with oxy-acetylene
___ ___ Welded with electric arc
___ ___ Welded with resistance welding method
___ ___ Welded with heliarc
___ ___ Inspected and tested welds
___ ___ Brazed and soldered structural members
___ ___ Layed out and welded pipe
___ ___ Hard surfaced and heat-treated metalic objects

Please list any other major types of welding tasks you have performed in the past two years:

____
____
____
____

Miscellaneous Activities

YES NO

___ ___ Rigged and hoisted materials
___ ___ Constructed or erected scaffolding
___ ___ Drew, sketched plans
___ ___ Estimated materials needed for a job
___ ___ Gave written instructions
___ ___ Received written instructions
___ ___ Received oral instructions
___ ___ Outlined facts in clear, logical order
___ ___ Used handbooks, manuals, catalogues, etc.
___ ___ Prepared technical reports in writing
___ ___ Developed specifications and schedules
___ ___ Operated lifting devices: cranes, winch, block and tackle, chain hoist, etc.
___ ___ Read blue prints
___ ___ Estimated time needed to do a job
___ ___ Estimated work force needed to complete a job
___ ___ Gave oral instructions
___ ___ Collected information, obtained facts and ideas
___ ___ Prepared charts, graphs, and pictures
___ ___ Used communication equipment: telephone, teletype, etc.

Please list any other major types of miscellaneous tasks you have performed in the last two years:

____
____
____

IRON WORKERS' QUESTIONNAIRE

If you have performed a task on your job in the past two years check (x) YES. If not (x) NO. Please check all items either YES or NO.

YES	NO	
___	___	Erected, assembled, or installed fabricated structural metal products in the construction of buildings, bridges, etc.
___	___	Erected, assembled, or installed metal storage tanks
___	___	Installed steel doors and frames, stairways, catwalks, floor gratings, ladders, metal cabinets, etc.
___	___	Erected, assembled, or installed crane runways or other heavy equipment supports
___	___	Installed steel floor or roof decking
___	___	Installed metal products by setting them in concrete
___	___	Cut, shaped, placed and tied reinforcing rod or steel mesh
___	___	Installed lamp posts, gates, fences, and decorative iron works
___	___	Installed aluminum, brass, copper and bronze metal shapes, frames, and panels (curtain wall, window wall)

Please list any other major types of iron working tasks you have performed in the past two years:

____

____

____

____

Miscellaneous Activities

___	___	Rigged and hoisted materials
___	___	Constructed or erected scaffolding
___	___	Drew, sketched plans
___	___	Estimated materials needed for a job
___	___	Gave written instructions
___	___	Received written instructions
___	___	Received oral instructions
___	___	Outlined facts in clear, logical order
___	___	Used handbooks, manuals, catalogues, etc.
___	___	Prepared technical reports in writing
___	___	Operated lifting devices: cranes, winch, block and tackle, chain hoist, etc.
___	___	Developed specifications and schedules

___ ___ Read blue prints
___ ___ Estimated time needed to do a job
___ ___ Estimated work force needed to complete a job
___ ___ Gave oral instructions
___ ___ Collected information, obtained facts and ideas
___ ___ Prepared charts, graphs, and pictures
___ ___ Used communication equipment: telephone, teletype, etc.

Please list any other major types of miscellaneous tasks you have performed in the last two years:

____
____
____
____

YES NO

___ ___ Layed out and installed girders, beams, supports, braces, etc. on the job or at the shop (plant)
___ ___ Spot welded metal studding and other structural members on the job or at the shop (plant)
___ ___ Cut metal to specified size using acetylene and/or carbon and steel electrode arc method
___ ___ Welded sheet-metal objects made of such metals as aluminum, brass, iron and steel, or such alloys as dural, monel, and stainless steel
___ ___ Welded with oxy-acetylene
___ ___ Welded with electric arc
___ ___ Welded with resistance welding method
___ ___ Welded with heliarc
___ ___ Inspected and tested welds
___ ___ Brazed and soldered structural members
___ ___ Layed out and welded pipe
___ ___ Hard surfaced and heat-treated metalic objects

Please list any other major types of welding tasks you have performed in the past two years:

____
____
____
____

PAINTERS' QUESTIONNAIRE

If you have performed a task on your job in the past two years check (x) YES. If not (x) NO. Please check all items either YES or NO.

YES NO

___ ___ Prepare surfaces of buildings and other structures for a finish
___ ___ Covered interior of rooms with paper, fabric, vinyls, or other materials
___ ___ Applied paint, varnish, enamel, lacquer and similar materials to surfaces
___ ___ Mixed and matched colors or paint
___ ___ Patched plaster surfaces

Please list any other major types of painting, paperhanging or related tasks you have perfromed in the last two years:

____
____
____
____

Miscellaneous Activities

YES NO

___ ___ Rigged and hoisted materials
___ ___ Constructed or erected scaffolding
___ ___ Drew, sketched plans
___ ___ Estimated materials needed for a job
___ ___ Gave written instructions
___ ___ Received written instructions
___ ___ Received oral instructions
___ ___ Outlined facts in clear, logical order
___ ___ Used handbooks, manuals, catalogues, etc.
___ ___ Prepared technical reports in writing
___ ___ Developed specifications and schedules
___ ___ Operated lifting devices: cranes, winch, block and tackle, chain hoist, etc.
___ ___ Read blue prints
___ ___ Estimated time needed to do a job
___ ___ Estimated work force needed to complete a job
___ ___ Gave oral instructions
___ ___ Collected information, obtained facts and ideas
___ ___ Prepared charts, graphs, and pictures
___ ___ Used communication equipment: telephone, teletype, etc.

Please list any other major types of miscellaneous tasks you have performed in the last two years:

____
____
____

PLASTERERS' QUESTIONNAIRE

If you have performed a task on your job in the past two years check (x) YES. If not (x) NO. Please check all items either YES or NO.

YES NO

___ ___ Applied plaster to interior walls and ceilings
___ ___ Applied decorative texture to plaster surfaces
(stipple, swirl, etc.)
___ ___ Mixed and transported plaster materials on the job
___ ___ Sprayed plaster on walls, ceilings, and structural
sections of buildings
___ ___ Applied stucco to exterior walls
___ ___ Formed and cast ornamental designs in plaster
___ ___ Molded decorative cornice work, paneling, or recesses
for indirect lighting

Please list any other major types of plastering tasks you have performed in the last two years:

____
____
____
____

Miscellaneous Activities

YES NO

___ ___ Rigged and hoisted materials
___ ___ Constructed or erected scaffolding
___ ___ Drew, sketched plans
___ ___ Estimated materials needed for a job
___ ___ Gave written instructions
___ ___ Received written instructions
___ ___ Received oral instructions
___ ___ Outlined facts in clear, logical order
___ ___ Used handbooks, manuals, catalogues, etc.
___ ___ Used communication equipment: telephone, teletype, etc.
___ ___ Developed specifications and schedules
___ ___ Operated lifting devices: cranes, winch, block and
tackle, chain hoist, etc.
___ ___ Read blue prints
___ ___ Estimated time needed to do a job
___ ___ Estimated work force needed to complete a job
___ ___ Gave oral instructions

___ ___ Collected information, obtained facts and ideas
___ ___ Prepared charts, graphs, and pictures

Please list any other major types of miscellaneous tasks you have performed in the last two years:

____
____
____
____

PLUMBERS' QUESTIONNAIRE

If you have performed a task on your job in the past two years check (x) YES. If not (x) NO. Please check all items either YES or NO.

YES NO

___ ___ Installed pipe systems, water, steam, air, sewage, etc.
___ ___ Caulked horizontal and vertical cast iron joints
___ ___ Made up screw pipe work
___ ___ Layed out house sewer
___ ___ Vented plumbing systems
___ ___ Tested roughing-in work
___ ___ Connected to city water main
___ ___ Fabricated connections in brass and copper pipe and tubing
___ ___ Altered and repaired existing pipe systems
___ ___ Installed hot water supply systems in large buildings and residential structures
___ ___ Installed pneumatic cold water system
___ ___ Installed lead sheets, flashing, etc.
___ ___ Installed garage, cellar, or other special floor drains
___ ___ Installed vacuum cleaner systems
___ ___ Installed water supply systems
___ ___ Installed sewer ejectors
___ ___ Installed bidlets
___ ___ Installed hot water incinerator system
___ ___ Installed gasoline pumps
___ ___ Tested water conditions (Bacteriology)
___ ___ Inspected and tested plumbing installations
___ ___ Operated plumber's furnace
___ ___ Cut, reamed, threaded, and bent wrought iron pipe

___ ___ Roughed-in work (drains, ground lines, soil stacks, ventilation) for Durham work small residential structures and multi-level or multi-unit structures
___ ___ Roughed-in water supply lines
___ ___ Installed range boiler and gas heater
___ ___ Installed plumbing fixtures, appliances, and heating and refrigeration units
___ ___ Installed return hot water systems
___ ___ Installed inserts in forms for concrete work
___ ___ Installed batteries of showers and urinals
___ ___ Installed filters
___ ___ Installed rust preventors
___ ___ Installed swimming pool equipment
___ ___ Installed hydraulic rams
___ ___ Installed ice water system
___ ___ Installed salt water system
___ ___ Installed acetylene gas system
___ ___ Installed hard and soft water system

Please list any other major types of plumbing or pipefitting tasks you have performed in the last two years:

____
____
____
____

ROOFERS' QUESTIONNAIRE

If you have performed a task on your job in the past two years check (x) YES. If not (x) NO. Please check all items either YES or NO.

YES NO

___ ___ Applied built-up asphalt, tar, and gravel roofs, to buildings
___ ___ Operated tar heater
___ ___ Installed gutters and downspout
___ ___ Water-proofed and dam-proofed walls, roofs, and other building surfaces
___ ___ Applied metal roofs
___ ___ Repaired roofs
___ ___ Installed composition roofing (all types) to surfaces of roofs
___ ___ Installed metal flashing where necessary

___ ___ Applied tile, terra cotta, and asbestos shingles to roof surfaces
___ ___ Applied wood shingles and/or shakes

Please list any other major types of roofing tasks you have performed in the last two years:

____
____
____
____

Miscellaneous Activities

YES NO

___ ___ Rigged and hoisted materials
___ ___ Constructed or erected scaffolding
___ ___ Drew, sketched plans
___ ___ Estimated materials needed for a job
___ ___ Gave written instructions
___ ___ Received written instructions
___ ___ Received oral instructions
___ ___ Outlined facts in clear, logical order
___ ___ Used handbooks, manuals, catalogues, etc.
___ ___ Prepared technical reports in writing
___ ___ Developed specifications and schedules
___ ___ Operated lifting devices: cranes, winch, block and tackle, chain hoist, etc.
___ ___ Read blue prints
___ ___ Estimated time needed to do a job
___ ___ Estimated work force needed to complete a job
___ ___ Gave oral instructions
___ ___ Collected information, obtained facts and ideas
___ ___ Prepared charts, graphs, and pictures
___ ___ Used communication equipment: telephone, teletype, etc.

Please list any other major types of miscellaneous tasks you have performed in the last two years:

____
____
____
____

SHEET METAL AND HEATING WORKERS' QUESTIONNAIRE

If you have performed a task on your job in the past two years check (x) YES. If not (x) NO. Please check all items either YES or NO.

YES	NO	
___	___	Fabricated and installed ducts which are used in ventilating, air conditioning, and heating systems
___	___	Fabricated and installed sheet metal roofing
___	___	Fabricated and installed commercial stainless steel kitchen equipment
___	___	Fabricated and installed metal framework associated with sign and display construction
___	___	Made alterations and repair on existing sheet metal work
___	___	Installed or serviced controls: electric
___	___	Installed or serviced controls: pneumatic
___	___	Fabricated and installed partitions, sheet metal shelves, chutes, etc.
___	___	Inspected sheet metal work
___	___	Placed sheet metal piling into ground around excavation to prevent cave-in
___	___	Fabricated and installed metal siding and trim

Please list any other major types of sheet metal tasks you have performed in the last two years:

____

____

____

____

Miscellaneous Activities

YES	NO	
___	___	Rigged and hoisted materials
___	___	Constructed or erected scaffolding
___	___	Drew, sketched plans
___	___	Estimated materials needed for a job
___	___	Gave written instructions
___	___	Received written instructions
___	___	Received oral instructions

___ ___ Outlined facts in clear, logical order
___ ___ Used handbooks, manuals, catalogues, etc.
___ ___ Prepared technical reports in writing
___ ___ Developed specifications and schedules
___ ___ Operated lifting devices: cranes, winch, block and tackle, chain hoist, etc.
___ ___ Read blue prints
___ ___ Estimated time needed to do a job
___ ___ Estimated work force needed to complete a job
___ ___ Gave oral instructions
___ ___ Collected information, obtained facts and ideas
___ ___ Prepared charts, graphs, and pictures
___ ___ Used communication equipment: telephone, teletype, etc.

Please list any other major types of miscellaneous tasks you have performed in the last two years:

____
____
____
____

YES NO

___ ___ Layed out and installed girders, beams, supports, braces, etc. on the job or at the shop (plant)
___ ___ Spot welded metal studding and other structural members on the job or at the shop (plant)
___ ___ Cut metal to specified size using acetylene and/or carbon and steel electrode arc method
___ ___ Welded sheet-metal objects made of such metals as aluminum, brass, iron and steel, or such alloys as dural, monel, and stainless steel
___ ___ Welded with oxy-acetylene
___ ___ Welded with electric arc
___ ___ Welded with resistance welding method
___ ___ Welded with heliarc
___ ___ Inspected and tested welds
___ ___ Brazed and soldered structural members
___ ___ Layed out and welded pipe
___ ___ Hard surfaced and heat-treated metalic objects

Please list any other major types of welding tasks you have performed in the past two years:

____
____
____

APPENDIX B

PERCENTAGES OF WORKERS IN EACH OF TEN BUILDING TRADES PERFORMING VARIOUS TYPES OF TASKS

Carpenters

Lay out building	90.7
Excavate for footings and foundation	72.2
Strip forms	95.9
Construct runways and ramps	76.9
Lay out and frame roofs	92.6
Fabricate light roof trusses	73.8
Apply roofing	65.2
Build entrances and porches	87.0
Hang window sash	90.5
Install wall boards	89.6
Apply door trim	97.3
Apply ceiling tile and trim	69.7
Install baseboards	95.8
Apply wall panels (plywood, masonite, etc.)	95.9
Install kitchen cabinets	83.3
Install newel posts and hand rails	64.7
Install floors (Asbestos, asphalt, vinyl, tile, linoleum, etc.)	48.4
Construct with heavy timbers (including laminated beams)	87.8
Fabricate cabinets and mill work	62.3
Construct window and sash	56.5
Fabricate interior jambs and linear trim	74.6
Prime (paint) base coat on wood materials	47.6
Apply metal finishes	46.6
Fabricate paneling (mill work)	53.2
Alter and repair existing structures	96.9
Determine soil conditions and drainage	26.4
Lay out and construct concrete forms	97.3
Frame sills, girders, joists, subfloors	95.9
Frame sidewalls, interior walls, apply sheathing	100.0
Install window and door frames	94.7
Apply side wall covering	91.4
Install cornices	75.0
Apply lath and plaster bases	30.0
Install door and window jambs	93.2
Install linen closets	83.3
Install stairs (finished)	84.7
Install floors (wood)	52.3
Hang doors	95.9
Install hardwood (hinges, catches, locks, etc)	98.7
Install piles and pile foundations	25.4

Carpenter continued

Build towers and bridges	20.3
Construct exterior door and window frames	67.7
Fabricate cabinets and cases	62.7
Apply varnish, paint, etc. (finish or final coat)	38.3
Fabricate cabinet and built-in stock (mill work)	58.7
Fabricate stairwork (mill work)	55.6

Cement Workers

Mix concrete on the job	80.0
Transport concrete (plant to job site)	00.0
Prepare and finish concrete floors, walls, etc., in multi-level buildings	57.1
Prepare and finish concrete on water resource projects (small dams, irrigation ditches, storage tanks)	100.0
Prepare and finish concrete paving, walks, curbs	50.0
Prepare concrete mix at plant	100.0
Sample and test concrete	00.0
Prepare and finish concrete floors, walls, etc., in residential homes	33.3
Operate power vibrators	100.0
Finish air-entrained concrete	57.1
Prepare and finish concrete project on farms	100.0
Prepare and apply shotcrete	00.0

Electricians

Design circuit, conduit, or duct layouts for residential, commercial, or industrial buildings	80.6
Wire in raceways	79.3
Install temporary construction wiring	86.7
Install, connect, or repair: single or multiphase distribution transformers	71.0
Install open wiring	63.0
Lay out, install, or maintain: DC or single and multiphase AC, branch or feeder circuits	75.0
Lay out or install: electrical/electronic signal systems (P.A., telephone, radio, T.V.)	75.9
Install switches and outlets	100.0
Install equipment and appliances	75.9
Lay out and assemble or install: electrical/electronic signs and controls	39.3

Electricians continued

Diagnose trouble, adjust or service: electrical/electronic motor and equipment controls (Manual, semiautomatic, or automatic) and/or instruments	83.3
Install or repair: DC, single or multi-phase AC motors, generators, and controls	71.0
Rewind DC, single, and multi-phase AC motors, generators, or transformers	10.3
Operate plant: including reading of load graphs and power surveys; maintaining voltage regulation; inspection of circuit breaker systems, etc.	27.6
Install interior industrial power systems: (steam plants, hydraulic plants, diesel plants, gas turbine plants and atomic plants)	34.8
Install cable wiring	69.0
Install underground/underwater wiring	56.7
Install surface wiring	72.4
Lay out, install, and/or repair single, multi-phase AC service and metering equipment	65.5
Install or service: DC or single and multiphase AC power distribution control equipment	60.0
Install overhead services	64.3
Install underground services	66.7
Install high voltage services (2,300 volts and above)	30.0
Design, lay out, install, or service: residential, commercial or industrial, interior/exterior lighting systems	76.7
Design, lay out, or install: electrical heating systems and controls	78.6
Diagnose trouble, service, or repair: electronic communications equipment	20.0
Diagnose trouble, service, or repair: electrical appliances, power tools (portable and stationary)	76.4
Lay out and install: X-Ray, radio/TV transmitter or hazardous location wiring systems	43.3
Install or maintain: power station or transmission line power distribution equipment (exterior)	18.5

Ironworkers (Structural, Ornamental, Reinforcement)

Erect, assemble, or install fabricated structural metal products in the construction of buildings, bridges, etc.	100.0
Erect, assemble, or install metal storage tanks	33.3

Ironworkers continued

Install steel doors and frames, stairways, catwalks, floor gratings, ladders, metal cabinets, etc.	88.9
Erect, assemble, or install crane runways or other heavy equipment supports	57.1
Install steel floor or roof decking	100.0
Install metal products by setting them in concrete	85.7
Cut, shape, place, and tie reinforcing rod or steel mesh	100.0
Install lamp posts, gates, fences, and decorative iron works	50.0
Install aluminum, brass, copper, and bronze metal shapes, frames, and panels (curtain wall, window wall)	66.7

Masons and Bricklayers

Lay out and install masonry and stone veneer walls	100.0
Cut masonry units	100.0
Set bearing plates for beams into masonry	77.0
Install pre-cast masonry units	87.5
Lay out, install, and finish steps, floors, walks, etc.	83.3
Lay out and install facing tile (exterior and interior)	69.2
Painted concrete surfaces	18.2
Sand blast exterior walls	10.0
Apply terrazo floors	18.2
Install fire brick and refractory brick lining	93.8
Install tilt-up masonry slabs	46.2
Mix and temper mortar	73.3
Lay out and install solid or cavity masonry walls (interior or exterior)	85.7
Lay out and install fireplaces, chimneys	93.3
Apply waterproofing to masonry surfaces	69.2
Wash, point, and caulk masonry work	93.3
Repair and maintain masonry structures	85.7
Grind and polish stone slabs	27.3

Painters and Paper Hangers

Prepare surfaces of buildings and other structures for a finish	94.1
Cover interior of rooms with paper, fabric, vinyls, or other materials	62.5

Painters and Paper Hangers continued

Apply paint, varnish, enamel, lacquer and similar materials to surfaces	94.4
Mix and match colors of paint	83.3
Patch plaster surfaces	100.0

Plasterers

Apply plaster to interior walls and ceilings	100.0
Apply decorative texture to plaster surfaces (stipple, swirl, etc.)	93.3
Mix and transport plaster materials on the job	50.0
Spray plaster on walls, ceilings, and structural sections of buildings	86.7
Apply stucco to exterior walls	100.0
Form and cast ornamental designs in plaster	38.5
Mold decorative cornice work, paneling, or recesses for indirect lighting	69.2

Plumbers and Pipe Fitters

Install pipe systems which carry water, steam, air, sewage, etc.	100.0
Caulk horizontal and vertical cast iron joints	90.9
Make up screw pipe work	100.0
Lay out house sewer	66.7
Vent plumbing systems	90.0
Test roughing-in work	100.0
Connect to city water main	33.3
Fabricate connections in brass and copper pipe and tubing	90.0
Alter and repair existing pipe systems	100.0
Install hot water supply systems in large buildings and residential structures	100.0
Install pneumatic cold water system	60.0
Install lead sheets, flashing, etc.	88.9
Install garage, cellar, or other special floor drains	70.0
Install vacuum cleaner systems	00.0
Install water supply systems	100.0
Install sewer ejectors	37.5
Install bidlets	56.0
Install hot water incinerator system	00.0

Plumbers and Pipe Fitters continued

Install gasoline pumps	44.0
Test water conditions (bacteriology)	12.5
Inspect and test plumbing installations	88.9
Operate plumber's furnace	100.0
Cut, ream, thread, and bend wrought iron pipe	81.8
Rough-in work (drains, ground lines, soil stacks, ventilation) for Durham work, small residential structures and multilevel or multiunit structures	88.9
Rough-in water supply lines	88.9
Install range boiler and gas heater	90.0
Install plumbing fixtures, appliances, and heating and refrigeration units	90.9
Install return hot water systems	100.0
Install inserts in forms for concrete work	100.0
Install batteries of showers and urinals	77.8
Install filters	56.0
Install rust preventors	00.0
Install swimming pool equipment	37.5
Install hydraulic rams	33.3
Install salt water system	12.5
Install ice water system	33.3
Install acetylene gas system	50.0
Install hard and soft water system	25.0

Roofing Workers

Apply built-up asphalt, tar, and gravel roofs to buildings	100.0
Operate tar heater	100.0
Install gutters and downspout	93.3
Water-proof and damp-proof walls, roofs, and other building surfaces	100.0
Apply metal roofs	18.2
Repair roofs	100.0
Install composition roofing (all types) to surfaces of roofs	93.8
Install metal flashing where necessary	92.9
Apply tile, terra cotta, and asbestos shingles to roof surfaces	53.3
Apply wood shingles and/or shakes	53.8

Sheet Metal Workers

Fabricate and install ducts which are used in ventilating, air conditioning, and heating systems	95.8
Fabricate and install sheet metal roofing	58.8
Fabricate and install commercial stainless steel kitchen equipment	45.8
Fabricate and install metal framework associated with sign and display construction	47.8
Make alterations and repair on existing sheet metal work	72.0
Install or service controls: electric	30.4
Install or service controls: pneumatic	16.7
Fabricate and install partitions, sheet metal shelves, chutes, etc.	47.6
Inspect sheet metal work	47.8
Place sheet metal piling into ground around excavation to prevent cave-in	00.0
Fabricate and install metal siding and trim	17.4

APPENDIX C

SOURCES OF INFORMATION UTILIZED TO CONCEPTUALIZE TASK IDENTIFICATION QUESTIONNAIRE AND KNOWLEDGE CHECK LIST

Courses of Study and Training Manuals

Courses of study from the Division of Vocational, Technical, and Adult Education, Spokane Community College, Spokane, Washington.

- Carpentry, Cabinet, and Detail Millwork, Course outline, 1966
- Sheet Metal, Course outline, 1966
- Basic Drafting and Design, Course outline, 1966
- Combination Welding, Course outline, 1966
- Architectural Drafting and Design, Course outline, 1966
- Industrial Drafting and Design, Course outline, 1966

Courses of study from the Division of Vocational, Technical, and Adult Education, Dade County Public Schools, Miami, Florida.

- Carpentry, 916V (Carpenters Apprentice 1): Course 926-1
- Carpenters' Apprentice 2: Course 926-2
- Apprentice Electrician Construction Wireman: Course 932
- Electrical Construction Wireman Apprentice 1: Course 932-1
- Electrical Construction Wireman Apprentice 2: Course 932-2
- Plumbing and Pipe Fitting: Course 962-1
- Plumbing and Pipe Fitting: Course 962-2
- Plumbing and Pipe Fitting: Course 962-3
- Roofers' Apprentice 1: Course 971-1
- Roofing, VIE 081: Course 971-2

Ironwork; Ironworkers Apprentice 1: Course 951-1

Ironwork, VIE 046; Ironworkers Apprentice 2: Course 951-2

Ironwork, VIE 046; Ironworkers Apprentice 3: Course 951-3

Sheet Metal Work, 985V; Sheet Metal Apprentice 1: Course 977-1

Sheet Metal Work, 985V; Sheet Metal Apprentice 2: Course 977-2

Welding, 994V; (Basic Skills and Technology for Arc Welding): Course 057

Welding, 994V; (Basic Skills and Technology for Oxyacetylene Welding): Course 059

Painting and Decorating (Painters and Decorators Apprentice 1): Course 968-1

Painting and Decorating, 965V (Painters and Decorators Apprentice 2): Course 968-2

Plastering (Plasterers' Apprentice 1): Course 958-1

Courses of Study from the Departments of Labour and Education, Province of British Columbia, Victoria, B.C.

Lathing: Programme of Studies and Schedule; Years I, II, and III, 1960.

Millwork and Joinery: Course of Study for Pre-Employment Training, 1960.

Millwork and Joinery: Trade Analysis, 1960.

Millwork and Joinery Apprentices· First, Second, Third, and Fourth Year Night School, 1960.

Tentative Outline of the Training Programme for Carpenter Apprentices, 1959.

Overall Course of Study for Plasterers Apprentice.

Overall Course of Study for Bridge and Structural Steel Erectors and Fabricators (Field) Apprentice

Courses of Study from the State Department of Education, Division of Vocational Education, Trade, and Industrial Education Service, Salem, Oregon.

Course of Technical Information for Carpenter Apprentices, 1958.

Course of Technical Information for Lather Apprentices, 1951.

Courses of Study from the Ohio Trade and Industrial Education Service, Division of Vocational Education, State Department of Education, Columbus, Ohio.

Electric Lineman, Series 100, 1963.

Electric Lineman, Series 200, 1958.

Electric Lineman, Series 300, 1960.

Electric Lineman, Series 400, 1962.

Residential Wiring, 1954.

Basic Electricity, 1953.

Understanding Radio, 1953.

Electronics, 1958.

Basic Instructional Units for the Electrical Trade

Electronics, Basic Electricity, 1962.

Bricklaying I, 1954.

Bricklaying II, 1955.

Tentative Outline of a Course of Study in Plumbing Shop Practice, 1963.

Plumbing I, 1953.

Plumbing II, 1953.

State Department of Labor and Industries, Washington State Apprenticeship Council, Olympia, Washington.

Spokane Area Plumbing and Pipefitting Apprenticeship Standards: Plumbers and Steamfitters, 1965.

Spokane Masonry Apprenticeship Standards: Bricklayer, Tile Setter, Terrazzo Worker, Cleaner, Pointer, and Caulker, 1964.

Northeastern Washington-Northern Idaho Sheet Metal Apprenticeship Standards: Sheet Metal, 1965.

Spokane Area Bridge, Structural, and Ornamental Ironworkers Apprenticeship Standards: Iron Workers, 1965.

Spokane Area Carpenters Apprenticeship Standards: Carpenters and Millwrights, 1965.

Spokane Area Electrical Apprenticeship Standards: Construction Electrician; Sign Electrician; Motor Winder; Radio, Television, Appliance, and Electronic Serviceman, 1963.

National Apprenticeship and Training Standards.

National Apprenticeship and Training Standards for the Electrical Contracting Industry, Washington, D.C.: U. S. Dept. of Labor, Bureau of Apprenticeship and Training, 1957.

National Apprenticeship and Training Standards for the Sheet Metal Industry. Washington, D. C.: U. S. Dept. of Labor, Bureau of Apprenticeship and Training, 1965.

National Bricklaying Apprenticeship Program and Standards. Washington, D. C.: U. S. Dept. of Labor, Bureau of Apprenticeship and Training, 1962.

National Standards of Apprenticeship for the Crafts of the Plastering Industry. Washington, D. C.: U. S. Dept. of Labor, Bureau of Apprenticeship and Training, 1965.

National Apprenticeship and Training Standards for Cement Masonry, Asphalt, and Composition Trade. Washington, D. C.: U. S. Dept. of Labor, Bureau of Apprenticeship and Training, 1960.

U. S. Department of the Air Force, OJT Programs. The U. S. Air Force OJT Programs proved to be the most comprehensive of any of the programs analyzed by the research group.

Department of the Air Force. Sheet Metal Worker: OJT Program No. JC 53330/50. U. S. Government Printing Office, Washington, D. C., September 1962.

Department of the Air Force. Apprentice Electrician: OJT Program No. JB 54230Z. U. S. Government Printing Office, Washington, D. C., January 1963.

Department of the Air Force. Electrician/Electrical Technician: OJT Program No. JC 54250/70Z. U. S. Government Printing Office, Washington, D. C., July 1963.

Department of the Air Force. Painter: OJT Program No. JC 55231/51. U. S. Government Printing Office, Washington, D. C., June 1963.

Department of the Air Force. Electrical Power Production Specialist: OJT Program No. JP 54350. U. S. Government Printing Office, Washington, D. C., September, 1961.

Department of the Air Force. Masonry and Concrete Worker: OJT Program No. JC551321/52. U. S. Government Printing Office, Washington, D. C., June 1963.

Department of the Air Force. Plumbing Specialist and Plumbing Supervisor (CDC 55255): OJT Program No. JC 56450Z/70Z. U. S. Government Printing Office, Washington, D. C., May 1963.

U. S. Office of Education Program Materials

U. S. Department of Health, Education and Welfare, Office of Education, Electrical Technology: A Suggested 2-Year Post High School Curriculum, OE-80006, U. S. Government Printing Office, Washington, D. C., 1960.

U. S. Department of Health, Education, and Welfare, Office of Education, Electronic Technology: A Suggested 2-Year Post High School Curriculum, OE-800009, U. S. Government Printing Office, Washington, D. C., 1960.

Technical Publications

Abbott, Arthur L., and Charles L. Smith. National Electrical Code Handbook. Ninth Edition. New York: McGraw-Hill Book Company, 1957.

Althouse, A. D., and C. H. Turnquist. Modern Welding Practice. Chicago: The Goodheart-Wilcox Company, Inc., 1958.

Baker, L. P., and H. S. Langland. *Architectural Metal Handbook.* Chicago: Lakeside Press, 1952.

Basic TIG Welding, Tungsten, Inert-Gas, Shielded-Arc. Albany: Delmar Publishers, Inc., 1962.

Bricklaying: Practical and Related Instruction. Albany: New York State Vocational and Practical Arts Association, Delmar Publishers, Inc., 1949.

Carpentry. Technical Manual. Department of the Army Technical Manual (TM5-226). Department of the Air Force Technical Order (TO 00-25-102). War Department, May 6, 1943.

Cement Mason's Manual for Residential Construction. Chicago: Portland Cement Association, 1960.

Concrete Technology. Chicago: Portland Cement Association in cooperation with the National Ready Mixed Concrete Association, 1965.

Construction Industry Opportunities Through Apprentice Training. Washington, D. C.: The Associated General Contractors of America, 1962.

Cooke, Nelson M., *Basic Mathematics for Electronics,* 2nd Edition, New York: McGraw-Hill Book Co., Inc., 1960.

Counselors Guide to Apprenticeable Occupations. Denver, Colorado: Colorado Apprenticeship Council, Colorado Industrial Commission, 1964.

D'Arcanglo, B., D'Arcangelo, Benedict, and Guest, J. R., *Blueprint Reading and Sketching: Plumbing Trades, Residential-Commercial,* Albany, New York: Delmar Publishers, Inc., 1956.

Daugherty, James S., and Powell, Robert E., *Sheet-Metal, Pattern Drafting and Shop Problems,* Peoria, Illinois: Chas. A. Bennett Co., Inc., 1959.

General Drafting, Department of the Army Technical Manual, (TM 5-230) Department of the Air Force Technical Order, (TO 00-25-103).

Giachino, J. W., and Others. *Welding Skills and Practices.* Chicago: American Technical Society, 1965 Edition.

Graham, Frank D., and Emery, Thomas J., *Audel's Plumbers and Steam Fitters Guides,* Vols. 1-4, New York: Theodore Audel and Company, 1949.

Graham, Kennard C., Industrial and Commercial Wiring, Chicago: American Technical Society, 2nd Edition, 1963.

Graham, Kennard C., Interior Electric Wiring: Part One, Residential. Chicago: American Technical Society, 6th Edition, 1961.

Graham, Kennard C., National Electrical Code and Blueprint Reading, Chicago: American Technical Society, 3rd Edition, 1965.

Graham, Kennard C., Understanding and Servicing Fractional Horsepower Motors, Chicago: American Technical Society, 1961.

Heiner, G. W., Dunlap, C. H., and Jones, C. S., How to Read Electrical Blueprints, Chicago: American Technical Society, 2nd Edition, 1963.

The International Association of Bridge Structural and Ornamental Ironworkers, Structural Steelwork Manual, St. Louis: The Association, 1959.

Jarvis, William D., Painting and Decorating Encyclopedia, Chicago: Goodheart-Willcox Company, Inc., 1959.

Jefferson, T. B., and Gorham Wood, Metals and How to Weld Them, Cleveland, Ohio: The James F. Tincder Avenue Welding Foundation, 1955.

Kaberlein, Joseph J., Air Conditioning Metal Layouts, Milwaukee: Bruce Publishing Company, 1941.

Manas, Vincent T., National Plumbing Code Handbook, Based on NPC ASA A40-8, New York: McGraw-Hill Book Company, Inc., 1957.

McCawley, James, Roofing, Estimating, Applying, Repairing, Chicago: Shelter Publications, 1959.

Newbecker, William, Sheet Metal Work, Chicago: American Technical Society, 1941.

O'Donnel, L. H., Reading Engineering Drawing, A Basic Systems Program, New York: Basic Systems, Inc., 1962.

The Oxy-Acetylene Handbook: A Manual on Oxy-Acetylene Welding and Cutting Procedures, New York: Linde Air Products Company, 1960 Edition.

Painting and Decorating Craftsman's Manual and Textbook, New York: Theodore Audel and Company, 1949.

Planning the Pre-Job Program for Brickmason Apprentices, Washington, D. C.: National Joint Bricklaying Apprenticeship Committee, 1961.

The Red Book of Good Lathing and Plastering Practices, Chicago: United States Gypsum Company, n.d.

Rice, Harold S., and Knight, Raymond M., Technical Mathematics, 2nd Edition, New York: McGraw-Hill Book Company, Inc., 1963.

Sheet Metal Workers and Apprenticeship Training, Washington, D. C.: Sheet Metal Workers' International Association (AFL-CIO) Research and Education Department, 1959.

Townsend, S. B., Carpentry, Chicago: American Technical Society, 1946.

U. S. Department of Labor, Bureau of Apprenticeship and Training, Apprenticeship and Training in Masonry Construction, Washington, D.C.: Bulletin-T-151, 1961.

U. S. Department of Labor, Dictionary of Occupational Titles, Volume 11: Occupational Classification and Industry Index, Washington, D. C.: U. S. Government Printing Office, March, 1965.

U. S. Department of Labor, Occupational Outlook Handbook, Washington, D. C.: U. S. Government Printing Office, 1963-64.

U. S. Department of Health, Education, and Welfare, Office of Education, Division of Vocational Education, Electrical and Electronic Technologies: OE-80004, Washington, D. C.: U. S. Government Printing Office, 1964.

U. S. Department of Health, Education, and Welfare, Office of Education, Division of Vocational Education, Mechanical Drafting and Design Technology: OE-80000, Washington, D. C.: U. S. Government Printing Office, 1964.

Van Den Branden, F., and Knowles, M., Plastering Skill and Practice, Chicago: American Technical Society, 1954.

Vogt, L. F., Fundamentals of Sheet Metal Layout, Basic Systems Program, New York: Basic Systems, Inc., 1964.

Wass, Alonzo, and Sanders, Gordon A., Building Construction: Roof Framing, Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1960.

Wilson, J. Douglas, Practical House Carpentry; Simplified Methods for Building, New York: McGraw-Hill Book Company, 1957.

D-1

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
BRICKLAYING											
PRINCIPLES OF MASONRY WORK											
Bond and lead construction	5	3	0	3	3	0	0	3	0	3	20
Function and methods of joints	5	3	3	0	3	0	0	0	0	0	14
Laying up corners (square and irregular)	5	0	0	0	0	0	0	0	0	0	5
Brick, block, tile, and stone installation techniques	5	0	0	0	0	0	0	0	0	0	5
Waterproofing masonry surfaces	5	3	5	3	0	5	0	0	5	0	26
Cleaning, pointing and caulking	5	3	3	3	3	3	0	0	3	3	26
Mortar mixtures and tempering or mortar	5	3	0	0	0	0	0	0	0	0	8
Cutting of masonry units	5	3	3	0	0	0	0	0	0	0	11
Setting bearing plates or beams into masonry	5	3	0	0	3	0	0	0	0	0	11

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Bricklaying continued											
Tilt-up masonry slab techniques	5	3	0	0	3	0	0	0	0	0	11
Reinforcement techniques	5	3	0	0	3	0	0	0	0	0	11
Construction and use of batter boards and story pole	5	3	0	0	0	0	0	0	0	0	8
Grouting	5	0	3	0	3	0	3	3	0	0	17
Effects of atmospheric conditions on masonry units and mortar	5	0	3	0	0	3	3	0	0	0	14
LAYOUT AND CONSTRUCTION METHODS											
Footings (requirements and types)	5	5	3	0	3	0	0	3	0	3	22
Foundation walls (types and design)	5	5	3	3	3	0	0	3	0	3	25
Masonry piers, columns, and pilasters	5	5	0	3	5	0	0	3	0	3	24
Masonry walls (interior and exterior)	5	3	3	3	3	3	3	3	3	3	32
Steps	5	5	3	3	5	3	3	0	0	0	24
Fireplaces (including installation of heatalators, etc.)	5	5	0	0	3	0	0	0	0	3	16

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Bricklaying continued											
Chimneys (interior and exterior--including flashing; capping)	5	5	0	0	0	0	0	0	5	5	20
Cornice detail	5	5	0	0	0	0	0	0	3	5	18
Arches (segmental; jack; semi-circular; gothic; elliptical)	5	5	0	0	5	0	5	0	0	0	20
Column and octagonal chimneys	5	5	0	0	5	0	0	0	5	5	25
Brick and stone veneer	5	5	0	3	0	0	0	3	3	3	22
CARPENTRY											
PRINCIPLES OF LAYING OUT BUILDING LINES	5	5	0	0	3	0	0	5	0	0	18
SOIL CONDITIONS AND DRAINAGE	0	5	5	0	0	0	0	5	0	0	15
EXCAVATION METHODS (PLANNING, ORGANIZATION, AND PROCEDURES)	3	5	3	3	3	0	0	5	0	0	22
TYPES OF FOUNDATIONS	3	5	0	3	3	0	0	3	0	3	20
METHODS USED IN CONCRETE FORM CONSTRUCTION											
Pier and wall footing forms	3	5	5	3	5	0	0	3	0	3	27

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Carpentry continued											
Concrete foundation wall forms	3	5	5	3	5	0	0	3	0	3	27
Steps (stair) forms	0	5	3	0	3	0	0	0	0	0	11
Floor and sidewalk slab forms	0	5	5	3	5	0	0	3	0	0	21
Forms for arched openings	5	5	3	0	5	0	0	0	0	0	18
Sectional forms	0	5	0	0	3	0	0	0	0	0	8
Reinforced concrete forms	5	5	5	5	5	0	0	5	0	5	35
PRINCIPLES OF LAYING OUT AND INSTALLING ANCHOR BOLTS	5	5	5	5	5	0	0	5	5	5	40
RUNWAYS, RAMPS, ETC., FOR TRANSPORTING CONCRETE (NOTE: FOR SPECIFIC KNOWLEDGES IN THE AREA OF CONCRETE, USE FORM: CONC/VI)	5	5	5	0	0	0	0	0	0	0	15
ANCHORS FOR INTERSECTING WALLS	5	5	0	0	5	0	0	0	0	0	15
TECHNIQUES OF STRIPPING FORMS	3	5	5	0	3	0	0	0	0	0	16
TYPES OF FRAME CONSTRUCTION	5	5	3	3	3	0	3	3	3	3	31

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Carpentry continued											
FRAMING METHODS	3	5	3	3	3	0	0	3	3	3	26
Girders	0	5	0	3	5	0	0	3	0	3	19
Columns	0	5	0	0	3	0	0	0	0	0	8
Sills	3	5	0	0	0	3	3	0	0	3	17
Joists	3	5	0	3	3	3	0	3	0	3	23
Floor openings	3	5	0	3	3	0	0	3	0	3	20
Subfloors	0	5	0	0	0	0	0	0	0	0	5
Side walls	3	5	0	3	0	0	0	3	0	3	17
Bay windows	0	5	0	0	0	0	0	0	0	0	5
Interior partitions	0	5	0	3	0	0	0	3	0	3	14
Stairways	0	5	0	3	0	0	0	3	0	3	14
Hearths, bathroom floors	3	5	0	0	3	0	0	3	0	3	17
Furring, grounds, backing	0	5	0	3	0	0	5	0	0	0	13
Entrances, porches	0	5	0	3	0	0	0	0	0	3	11

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Carpentry continued											
TYPES AND METHODS OF INSTALLING PRE-FABRI-CATED COMPONENTS	0	5	0	0	5	0	0	0	0	0	10
SHEATHING: TYPES AND METHODS OF APPLICATION	3	5	0	0	0	0	0	0	5	0	13
INSULATION: TYPES AND METHODS OF APPLICATION	0	5	0	0	0	0	0	0	5	5	15
ROOF FRAMING											
Types of roofs	0	5	0	0	0	0	0	0	3	3	11
Laying out roof plan	0	5	0	0	0	0	0	0	3	3	11
Equal pitched roofs	0	5	0	0	0	0	0	0	3	3	11
Unequal pitched roofs	0	5	0	0	0	0	0	0	3	3	11
Dormers	0	3	0	0	0	0	0	0	3	3	9
Pentagon, Hexagon and Octagon roof framing methods	0	3	0	0	0	0	0	0	3	0	6
ROOF TRUSSES (LIGHT WEIGHT), METHODS OF FABRICATION	0	5	0	0	0	0	0	0	0	0	5
HEAVY TIMBER CONSTRUCTION	0	3	0	0	0	0	0	0	0	0	3
Principles of timber framing	0	3	0	0	3	0	0	0	0	0	6

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Carpentry continued											
Types of truss construction	0	3	0	0	3	0	0	0	0	0	6
Types of let-in joints	0	3	0	0	0	0	0	0	0	0	3
Fasteners and connectors	0	3	0	0	3	0	0	0	0	0	6
Piles and pile foundations	0	3	0	0	5	0	0	0	0	0	8
Floor framing methods	0	3	0	0	0	0	0	0	0	0	3
Roof framing and trusses	0	3	0	0	0	0	0	0	0	0	3
Towers and bridges	0	3	0	0	5	0	0	0	0	0	8
EXTERIOR TRIM METHODS											
Cornices	0	5	0	0	0	3	0	5	0	3	16
Wood shingles and composition roof coverings	0	5	0	0	0	0	0	0	5	0	10
Window and door frames	0	5	0	0	0	3	0	0	0	0	8
Pre-fabricated frames	0	5	0	0	0	0	0	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Carpentry continued											
Side wall coverings	3	5	0	0	0	0	0	0	0	3	11
Entrances, porches	0	5	0	0	0	3	0	0	0	0	8
INTERIOR TRIM METHODS											
Hanging window sash	3	5	0	0	3	0	0	0	0	0	11
Applying lath and plaster bases	0	5	0	0	0	0	3	0	0	0	8
Installing wall boards	0	5	0	0	0	0	3	0	0	0	8
Installing door and window jambs	3	5	0	0	0	0	0	0	0	0	8
Applying door trim	0	5	0	0	0	0	0	0	0	0	5
Installing baseboards	0	5	0	3	0	3	0	0	0	0	11
Applying ceiling tile and trim	0	5	0	0	0	0	0	0	0	0	5
Applying wall panels	0	5	0	3	0	0	0	0	0	0	8
Installing kitchen cabinets	0	5	0	3	0	3	0	3	0	0	14

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating--Air Conditioning)	TOTAL
Carpentry continued											
Installing linen closets	0	5	0	0	0	3	0	0	0	0	8
Installing newel posts and hand rails	0	5	0	0	0	0	0	0	0	0	5
Installing stairs (finished)	0	5	0	0	0	0	0	0	0	0	5
Installing floors (wood)	0	5	0	0	0	3	0	3	0	0	11
Installing floors (tile, linoleum)	0	0	0	0	0	3	0	0	0	0	3
Hanging doors, exterior and interior	3	5	3	0	5	0	0	0	0	0	16
Installing hardware	0	5	0	0	0	3	0	0	0	0	8
CABINET MAKING (MILLWORK)											
Exterior frame construction	0	5	0	0	0	3	0	0	0	0	8
Window and sash construction	0	5	0	0	0	3	0	0	0	0	8
Interior jambs and linear trim	0	5	0	0	0	0	0	0	0	0	5
Cabinets and casework	0	3	0	0	0	0	0	3	0	0	6
Cabinets and built-in stock	0	3	0	0	0	0	0	3	0	0	6

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Carpentry continued											
Paneling	0	5	0	0	0	3	0	0	0	0	8
Stairwork	0	5	0	0	0	0	0	0	0	0	5
CONCRETE											
PROPERTIES OF CONCRETE	0	0	5	0	0	0	0	0	0	0	5
TYPES AND USES OF CONCRETE											
Reinforced concrete	3	5	5	3	5	0	0	3	0	3	27
Pre-cast concrete	3	3	5	5	5	0	0	3	0	3	27
Prestressed concrete	3	3	5	5	3	0	0	3	0	3	25
Light-weight concrete	3	3	5	3	3	0	0	3	0	3	23
Thin-shell construction	0	3	5	3	3	0	0	3	0	3	20
Shotcrete (pneumatically applied portland cement, plaster, or concrete)	0	0	5	3	3	0	0	0	0	0	11
Tilt-up construction	0	3	5	3	3	0	0	3	0	3	20
Concrete sandwich wall	0	3	5	3	3	0	0	3	0	3	20
Lift-slab construction	0	3	5	3	3	0	0	3	0	3	20

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Concrete continued											
Paving with concrete	3	3	5	0	3	0	0	3	0	0	17
Concrete for airports	0	3	5	3	3	0	0	3	0	3	20
Soil-cement paving											
Home building with concrete	3	5	5	3	0	3	3	5	0	5	32
Structural and architectural uses											
Agricultural uses	0	3	0	3	0	0	0	3	0	0	9
Water resources (storage tanks, ditches, canals, etc.)	0	0	5	0	3	0	0	3	0	0	11
QUALITY CONTROL METHODS	3	5	5	0	0	0	0	0	0	0	13
TECHNIQUES OF MIXING WATER FOR CONCRETE											
Purity control	3	5	3	0	0	0	0	0	0	0	11
Water analysis checking technique											
Effects of common impurities	3	5	3	0	0	3	3	0	0	0	17
AIR-ENTRAINED CONCRETE											
Effect of entrained on properties of fresh and hardened concrete	0	0	5	0	0	0	0	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Concrete continued											
Air entraining materials	0	0	5	0	0	0	0	0	0	0	5
Factors affecting air content											
Measurement of air content											
Selection and Design of Concrete Mixtures											
Designing concrete mixtures--unit weight method	0	5	5	0	0	0	0	3	0	0	13
Factors affecting quality of concrete	0	5	5	0	0	0	0	3	0	0	13
Selecting mix characteristics	0	5	5	0	0	0	0	3	0	0	13
Trial mix method	0	5	5	0	0	0	0	0	0	0	10
Laboratory trial mix methods	0	3	3	0	0	0	0	0	0	0	6
Job-size trial batches	0	5	5	0	0	0	0	0	0	0	10
Sampling and Testing Plastic Concrete											
Standard test methods	0	3	5	0	0	0	0	0	0	0	8
Sampling fresh concrete	0	3	5	0	0	0	0	0	0	0	8

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Concrete continued											
Tests for consistency	0	3	5	0	0	0	0	0	0	0	8
Unit weight test procedure	0	3	3	0	0	0	0	0	0	0	6
Testing for air content											
Follow-up tests											
READY MIXED CONCRETE	0	0	5	0	0	0	0	0	0	0	5
Production methods	0	3	3	0	0	0	0	0	0	0	6
Specifications	3	5	5	0	0	0	0	0	0	0	13
Delivery procedures	3	5	5	0	0	0	0	0	0	0	13
Precautions	3	5	5	0	0	0	0	0	0	0	13
JOB MIXING CONCRETE											
Production techniques	0	5	5	0	0	0	0	0	0	0	10
Determining exposure conditions	0	5	5	0	0	0	0	0	0	0	10
Water-cement ratios	0	5	3	0	0	0	0	0	0	0	8

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Concrete continued											
Consistency control	0	5	5	0	0	0	0	0	0	0	10
Selection of ingredients	0	3	3	0	0	0	0	0	0	0	6
Proportioning materials	0	3	3	0	0	0	0	0	0	0	6
Measuring materials	0	3	3	0	0	0	0	0	0	0	6
Mixing procedures	0	3	3	0	0	0	0	0	0	0	6
PLACING CONCRETE											
Preparation of site	0	5	5	0	0	0	0	0	0	0	10
Time limits for delivery and discharge	0	5	5	0	0	0	0	0	0	0	10
Transportation at job site	0	5	5	0	0	0	0	0	0	0	10
Placing concrete in forms	0	5	5	0	3	0	0	0	0	0	13
Precautions in adding water to mix	0	5	5	0	0	0	0	0	0	0	10
Drop chute	0	5	5	0	0	0	0	0	0	0	10

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Concrete continued											
Power vibrators	0	5	5	0	5	0	0	0	0	0	15
FINISHING CONCRETE SLABS											
Consolidating	0	5	5	0	0	0	0	0	0	0	10
Striking off	0	5	5	0	0	0	0	0	0	0	10
Edging and jointing	0	5	5	0	0	0	0	0	0	0	10
Floating	0	5	5	0	0	0	0	0	0	0	10
Finishing methods (broom, burlap, hand float, etc.)	0	5	5	0	0	0	0	0	0	0	10
Finishing air-entrained concrete	0	0	5	0	0	0	0	0	0	0	5
CURING CONCRETE: METHODS, REQUIREMENTS	0	0	5	0	0	0	0	0	0	0	5
JOINTS FOR FLAT CONCRETE WORK											
Purpose of joints	0	5	5	5	5	0	0	5	0	5	30
Isolation joints for points of abutment	0	5	5	5	5	0	0	5	0	5	30
Control joints to predetermine crack locations	0	5	5	5	5	0	0	5	0	5	30

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Concrete continued											
Construction joints for placing large areas in stage	0	5	5	5	5	0	0	5	0	5	30
Combination control and construction joints	0	5	5	3	5	0	0	3	0	3	24
REINFORCEMENT FOR CONCRETE											
Types of reinforcement used	3	5	5	3	5	0	0	3	0	3	27
Principles of reinforcement	3	5	0	0	5	0	0	0	0	0	13
Temperature and moisture changes	0	3	5	0	3	0	0	0	0	0	11
Placement of steel	0	3	0	0	5	0	0	3	0	3	14
Splicing reinforcement	0	3	0	0	5	0	0	0	0	0	8
Slab reinforcement	0	5	0	0	5	0	0	3	0	3	16
Concreting around steel	0	3	5	0	3	0	0	0	0	0	11
Reinforced concrete accessories	3	3	5	0	5	0	0	0	0	0	16
CONCRETING DURING HOT WEATHER											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Concrete continued											
Effect of elements on concrete	3	3	5	0	0	0	0	0	0	0	11
Methods	0	3	5	0	0	0	0	0	0	0	8
Testing specimens	0	3	5	0	0	0	0	0	0	0	8
Admixtures	3	3	5	0	0	0	3	0	0	0	14
CONCRETING DURING COLD WEATHER											
Effect on elements on concrete	5	5	5	0	0	0	5	0	0	0	20
Chemical accelerators	5	3	5	0	0	0	5	0	0	0	18
No-freez preventing chemicals	0	5	5	0	0	0	3	0	0	0	13
Curing methods	0	5	5	0	0	0	3	0	0	0	13
Removing forms	3	5	5	0	0	0	0	0	0	0	13
WATERPROOFING AND OTHER ADDITIVES											
ELECTRICIAN											
KNOWLEDGE OF WIRING METHODS											
Open wiring	0	3	0	5	3	0	0	3	3	3	20

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
Cable wiring	3	3	0	5	0	0	0	0	0	0	11
Underground/underwater wiring	0	0	3	5	3	0	0	0	0	3	14
Wiring in raceways	0	3	0	5	3	0	0	0	0	3	14
Surface wiring	3	0	0	5	3	0	0	3	0	3	17
Temporary construction wiring	3	3	3	5	3	3	3	3	3	3	32
Special wiring methods: including signal systems, computers, radiation, etc.	0	3	0	5	0	0	0	0	0	3	11
KNOWLEDGE OF SERVICES AND LOAD METERING: PRINCIPLES AND PRACTICES											
Overhead services	3	3	0	5	0	0	0	0	0	3	14
Underground services	3	0	3	5	0	0	0	3	0	3	17
High voltage services (2300 volts and above)	0	0	0	5	0	0	0	0	0	0	5
Installation methods (layout and procedures)	0	3	0	5	3	0	0	0	3	3	17

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
Load meters: including KWH, demand, recording, etc.	0	0	0	5	0	0	0	0	0	0	5
BRANCH & FEEDER CIRCUITS: PLANNING AND INSTALLATION METHODS											
Determining number and size required	0	0	0	5	0	0	0	0	0	0	5
Over-current protection (requirements, methods, equipment)	0	0	0	5	0	0	0	3	0	3	11
Layout and installation of runs	0	3	0	5	3	0	0	0	0	3	14
Old work procedures	3	3	0	5	0	0	0	3	3	3	20
KNOWLEDGE OF FINISHING PROCEDURES (INSTALLATION AND CONNECTION METHODS)											
Running circuits	0	3	0	5	3	0	0	0	0	3	14
Switches and outlets	3	3	0	5	0	0	0	0	0	3	14
Equipment and appliances	0	3	0	5	3	0	0	3	0	3	17
Signal equipment (PA, telephone, radio, TV)	0	3	0	5	3	0	0	0	0	3	14

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
Hanging fixtures	3	3	0	5	5	3	3	3	0	3	28
KNOWLEDGE OF LIGHTING PRINCIPLES AND PRACTICES	0	0	0	3	0	0	0	0	0	0	3
CONCEPT OF ADEQUATE WIRING (PRINCIPLES OF ADEQUATE DESIGN)	0	0	0	5	0	0	0	0	0	0	5
Lighting devices (lamps, tubes, panels): types, applications, basic characteristics	0	3	0	5	3	0	0	0	0	3	14
Design, layout, installation procedures	0	3	0	5	3	0	0	0	0	0	11
Showcase, display, show window practices	0	0	0	5	3	0	0	0	0	3	11
Electrical/electronic signs: design, construction methods	0	0	0	5	3	0	0	3	0	3	14
Industrial luminaires	0	0	0	5	0	0	0	0	0	3	8
Work area requirements	0	3	0	3	3	3	3	3	0	3	21

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
Determining required illumination values	0	0	0	3	0	0	0	0	0	0	3
Outdoor lighting	0	0	0	5	3	0	0	0	0	0	8
KNOWLEDGE OF INDUSTRIAL POWER SYSTEMS: MECHANICAL CONSTRUCTION, COMPONENTS, OPERATION											
Steam plants											
Hydraulic plants											
Diesel plants											
Gas turbine plants											
Atomic plants											
Plant operations: including load graphs and surveys, voltage regulation, inspection, circuit breaker systems, etc.											
Switch and panelboards	3	3	3	5	3	3	3	3	0	3	24

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
Switchgear: indoor, outdoor	0	0	0	5	3	0	0	0	0	0	8
Switchyard layout procedures	0	0	0	5	3	0	0	0	0	0	8
Circuit breakers: types and operating principles	0	0	0	5	0	0	0	0	0	3	8
Short circuit and lightning protection: principles and application methods	0	0	0	5	0	0	0	0	0	0	5
Transmission lines: including line equipment and its application	0	0	0	5	5	0	0	0	0	3	13
Distribution systems: including tree, feeder and main, network, loop, lines, arc circuits, etc.	0	0	0	5	0	0	0	0	0	0	5
Distribution transformers: types, applications and installation methods	0	0	0	5	3	0	0	0	0	0	8
Distribution relays: types and applications (including time delay, instantaneous, inverse time, induction, overcurrent protection, etc.)	0	0	0	5	0	0	0	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued Economics of electrical power systems: including a knowledge of government regulations, principles of rate making, equipment depreciation methods, taxes, and operational factors influencing KWH costs.											
ELECTRICAL CONTROLS: CIRCUITS AND DEVICES											
DC acceleration and speed controls	0	0	0	5	0	0	0	0	0	0	5
Multiple motor controls	0	0	0	5	0	0	0	0	0	0	5
Synchronizing motor drive controls	0	0	0	5	0	0	0	0	0	0	5
Two-series motor drives: types and methods	0	0	0	5	0	0	0	0	0	0	5
AC contactors and relays: including series, overload and phase failure and reversal	0	0	0	5	0	0	0	0	0	0	5
Slip-ring motor control systems	0	0	0	5	0	0	0	0	0	0	5
Squirrel cage motor control systems: including auto-transformer starters	0	0	0	5	0	0	0	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
System control methods and devices: including photoelectric, temperature, fluid flow, electro-mechanical, lighting, etc.	0	0	0	5	3	0	0	3	0	3	14
Controller devices: types and operation (including thermocouples, electronic speed regulators, magnetic amplifiers, saturable reactors, techometers, photo electric, differential transformers, etc.)	0	0	0	5	3	0	0	3	0	3	14
KNOWLEDGE OF THE TYPES, CARE AND APPLICATION OF ELECTRICAL TEST INSTRUMENTS											
Voltmeters: including DC and AC	0	0	0	5	0	0	0	3	0	3	11
Ammeters: including DC, AC, clampon, etc.	0	0	0	5	0	0	0	0	0	3	8
Ohmmeters	0	0	0	5	0	0	0	0	0	3	8
Meggers	0	0	0	5	0	0	0	0	0	0	5
Meggonmer	0	0	0	5	0	0	0	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
Watt-meters (1 and 3 phase)	0	0	0	5	0	0	0	0	0	3	8
Frequency meters	0	0	0	3	0	0	0	0	0	0	3
Power factor meters	0	0	0	3	0	0	0	0	0	0	3
Synchronoscope											
Phase sequence meters											
Meter phase switching principles											
Meter calibration techniques											
Integrating meters											
Instrument transformer metering: principles and applications	0	0	0	5	0	0	0	0	0	0	5
Multimeters: VOM	0	3	0	5	3	0	0	3	0	3	17
Output meters	0	0	0	3	0	0	0	0	0	0	3
Vacuum tube voltmeters	0	0	0	3	0	0	0	0	0	3	6

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
Cathode-ray oscilloscopes	0	0	0	3	0	0	0	0	0	0	3
Signal generators - RF and audio											
Sweep oscillators											
Tube testers	0	0	0	3	0	0	0	0	0	3	6
Capacitor checkers	0	0	0	3	0	0	0	0	0	0	3
Signal tracers											
Impedance bridges	0	0	0	3	0	0	0	0	0	0	3
Capacitance bridges	0	0	0	3	0	0	0	0	0	0	3
Field strength meters											
Function generators											
Pulse generators											
PRINCIPLES OF DC CIRCUITS AND MACHINES											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
Electrical units (including unit prefixes)	0	0	0	5	0	0	0	0	0	3	8
Series Circuits	0	0	0	5	0	0	0	0	0	3	8
Parallel Circuits	0	0	0	5	0	0	0	0	0	3	8
Series - parallel circuits	0	0	0	5	0	0	0	0	0	3	8
Circuit laws: including Ohm's law, Kirchoff's, etc.	0	0	0	5	0	0	0	0	0	3	8
Electro-chemical principles: batteries and cells	0	3	0	5	3	0	0	3	0	3	17
Insulators and conductors	0	3	0	5	3	0	0	3	3	3	20
Magnetism	0	0	0	5	0	0	0	3	0	3	11
Electro capacitance laws and units	0	0	0	5	0	0	0	0	0	0	5
Electrical machines: motors and generators: types and characteristics	0	0	0	5	0	0	0	0	0	3	8

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued *PRINCIPLES OF AC CIRCUITS*											
AC wave forms	0	0	0	5	0	0	0	0	0	0	5
Peak values: calculation method	0	0	0	5	0	0	0	0	0	0	5
Capacitors, capacitive reactance, phase angles	0	0	0	5	0	0	0	0	0	0	5
Inductors, inductive reactance, phase angles	0	0	0	5	0	0	0	0	0	0	5
Voltamperes, power factor, reactive power, and power	0	0	0	3	0	0	0	0	0	0	3
Single-phase parallel circuits: RC, RL, RLC, resonance	0	0	0	3	0	0	0	0	0	0	3
Single-phase series circuits: RC, RL, RCL, resonance	0	0	0	3	0	0	0	0	0	0	3
Series-parallel circuit principles	0	0	0	3	0	0	0	0	0	3	6

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
Polyphase circuit systems: including balanced & unbalanced wye and delta circuits, power measurements, etc.	0	0	0	5	3	0	0	3	0	3	14
Integrating and differentiating circuits											
AC MACHINES: TYPES AND CHARACTERISTICS											
Transformers: Principles and characteristics, single and 3-phase	0	0	0	5	0	0	0	0	0	3	8
Alternators: AC generating systems	3	3	0	5	3	0	0	3	3	3	23
Three-phase motors: principles and characteristics	0	0	0	5	0	0	0	0	0	0	5
Three-phase synchronous motors	0	0	0	5	0	0	0	0	0	0	5
Synchronous converters	0	0	0	5	0	0	0	0	0	0	5
Single-phase motors	3	3	0	5	3	0	0	3	0	3	20
ELECTRONIC PRINCIPLES AND CIRCUIT CHARACTERISTICS											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
Vacuum tube characteristics											
Semiconductor characteristics											
Power supply fundamentals	0	0	0	3	0	0	0	0	0	3	6
Audio amplifier circuits	0	0	0	3	0	0	0	0	0	0	3
Radio frequency amplifiers											
Tuning circuits											
Oscillators: types and circuitry											
Detector circuits											
Receiving circuits: including AM, FM, TV, pulse, etc.											
Diagnostic and service procedures	0	0	0	3	0	0	0	0	0	3	6
Feedback circuits											
Timing circuits	0	0	0	3	0	0	0	0	0	3	6

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Electrician continued											
Thermonic electronic circuits: diethermy, induction heaters, pyrometers, etc.	0	0	0	3	0	0	0	0	0	0	3
Photoelectric circuitry	0	0	0	3	0	0	0	0	0	3	6
Power conversion (rectification) principles; including thyratrons, ignitions, etc.											
DC generator and motor electronic control circuitry	0	0	0	5	0	0	0	0	0	0	5
AC motor electronic control circuits	0	0	0	5	0	0	0	0	0	0	5
Electronic heating system control circuits	0	0	0	5	0	0	0	0	0	3	8
IRONWORKING *REINFORCED CONCRETE CONSTRUCTION*											
Nature of reinforced concrete (cementitious portion, aggregate portion, steel portion)	0	3	3	0	3	0	0	0	0	0	9

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Ironworking continued											
Properties of reinforced concrete (tensile strength, shear strength, compression strength, durability, weathering properties)	0	3	3	0	3	0	0	0	0	0	9
REINFORCED CONCRETE INSTALLATION											
Buildings, (types, methods of erection, components)	0	3	3	5	5	0	0	5	0	5	26
Floors (slab - girder, flat plate, concrete joist, slab on steel beams)	0	3	3	5	5	0	0	5	0	5	26
Walls (methods of bar setting, precautions to be followed, types of bends in bars, methods of tying bars)		3	0	0	5	0	0	3	0	0	11
Roofs (supports, columns, methods of installing steel, layout of bars, precautions to be followed)	0	3	0	0	5	0	0	0	0	0	8
Arches, shells and domes (types, methods of installing steel, techniques of making bends, precautions to be followed, techniques of setting bars)	0	3	0	3	5	0	0	3	0	0	14

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Ironworking continued											
Bins and tanks (types, methods of erection, precautions to be followed on each type, bar setting and layout)	0	0	0	3	5	0	0	0	0	0	8
Proper marking of bars	0	0	0	0	5	0	0	0	0	0	5
Preparation of bars for use	0	0	0	0	5	0	0	0	0	0	5
Rules for bending bars	0	0	0	0	5	0	0	0	0	0	5
PLACEMENT OF STEEL ON JOB											
Importance of accuracy	0	3	0	0	5	0	0	0	0	0	8
Use of placement plans	0	0	0	3	5	0	0	3	0	3	14
Supporting and tying steel bars	0	0	0	0	5	0	0	0	0	0	5
Following proper procedures	0	0	0	0	5	0	0	0	0	0	5
Proper handling of materials on delivery	0	0	0	0	5	0	0	0	0	0	5
Methods of storing bars	0	0	0	0	5	0	0	0	0	0	5
Importance of following detailed routing	0	0	0	0	5	0	0	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES" CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Ironworking continued											
Importance of proper hoisting schedule	0	0	0	0	5	0	0	0	0	0	5
Importance of having proper materials at hand	0	0	0	0	5	0	0	0	0	0	5
Safe methods of handling bars and wire	0	0	0	0	5	0	0	0	0	0	5
STRUCTURAL STEELWORK											
Structural materials (structural shapes, properties and functions of each, load bearing qualities)	0	0	0	0	5	0	0	0	0	0	5
Connections used in structural work (reveted seats and frames, welded seats and tops, pin connections)	0	0	0	0	5	0	0	0	0	0	5
Parts of structures (trusses, purlins, struts, columns, girts and footings)	0	3	0	0	5	0	0	0	0	0	8
Description and functions of each part and methods of recognition	0	3	0	0	5	0	0	0	0	0	8
LAYOUT OF STEEL											
Methods and equipment to be used	0	3	0	0	5	0	0	0	0	0	8

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Ironworking continued											
Time schedules	0	0	0	0	5	0	0	0	0	0	5
Fabrication control	0	0	0	0	5	0	0	0	0	0	5
Personnel selection	0	0	0	0	5	0	0	0	0	0	5
Progress schedules	0	0	0	0	5	0	0	0	0	0	5
Follow-up methods for work control	0	0	0	0	5	0	0	0	0	0	5
Marking of steel (template marking, methods of measuring, etc.)	0	0	0	0	5	0	0	0	0	0	5
ERECTION											
Determining material and equipment placement	0	0	0	0	5	0	0	0	0	0	5
Determining lifting, riveting, and welding schedule	0	0	0	0	5	0	0	0	0	0	5
Setting columns	0	0	0	0	5	0	0	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Ironworking continued											
Placing beams	0	0	0	0	5	0	0	0	0	0	5
Fitting up, reaming methods	0	0	0	0	5	0	0	0	0	0	5
Bracing, (fixed, temporary and adjustable bracing)	0	3	0	0	5	0	0	0	0	0	8
FINISH IRON WORK, METHODS OF FABRICATION											
Cutting techniques	3	3	3	3	5	0	0	3	3	3	26
Shearing techniques	0	0	0	0	5	0	0	0	0	3	8
Shaping techniques (breaking, bending, forming, forging)	3	3	0	3	5	0	0	3	0	3	20
Joining techniques (bolting, riveting, seaming, soldering, brazing)	3	0	0	3	5	0	0	3	3	3	20
Heat treating (annealing, hardening, etc.)	0	0	0	3	5	0	0	3	0	5	16
Surface work (pickling, passivation, blast, cleaning, grinding, hammering, burnishing, brashing, polishing, buffing, etching)	3	0	0	3	5	0	0	0	0	3	14

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Ironworking continued											
INSTALLATION OF FINISH WORK											
Stairs (types, kinds, uses, installation methods, code requirements, precautions to be observed)	0	0	0	0	5	0	0	0	0	0	5
Fire escapes	3	3	0	3	5	0	0	0	3	0	17
Door frames and entrances	3	0	0	0	5	0	0	0	0	3	11
Balconies	3	0	0	0	5	0	0	0	3	0	11
Store fronts	3	3	0	0	5	0	0	0	0	3	14
Window frames	3	3	0	0	5	0	0	0	0	3	14
Railings	3	0	0	0	5	0	0	3	0	3	14
Protective building products (guards, chimney hardware, and door hardware)	3	3	0	3	5	3	0	0	3	3	23
Fences and gates	3	3	3	0	5	0	0	3	0	3	20
ARCHITECTURAL METAL SPECIFICATIONS											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Ironworking continued											
Classification of products(method of determination, by kinds of metal, type of building, and extent of project)	0	3	0	3	5	0	0	3	0	3	17
Painting and finishing specifications	3	3	3	3	5	5	3	3	0	3	31
PAINTING											
FINISHING METHODS											
Brushing	5	3	3	5	5	5	0	5	5	5	41
Spraying	5	3	3	5	5	5	0	5	5	5	41
Aerosol spraying	0	3	3	5	0	3	0	5	0	5	24
Dipping and flow coating	0	0	0	3	0	3	0	0	0	3	9
Roller coating	0	3	3	3	0	5	0	0	3	5	22
Tumbling	0	0	0	0	5	0	0	0	0	5	10
METHODS OF PROCEDURE											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Painting continued											
Cleaning surfaces	5	3	5	5	5	5	3	5	0	5	41
Removing old finish (chemical and heat methods)	0	0	0	3	3	5	0	3	0	3	17
Natural finishes	0	0	0	0	0	5	0	0	0	0	5
Smoothing surfaces	0	5	0	0	0	5	0	0	5	0	15
Filling holes and cracks	0	5	0	0	0	5	0	0	0	0	10
Repairing damaged plaster	0	3	0	3	0	5	5	3	0	3	22
Neutralizing lime in new plaster	0	0	0	0	0	0	5	0	0	0	5
Priming and finishing metal	0	3	0	5	5	5	0	5	5	5	33
Taping dry wall	0	3	0	3	0	5	3	3	0	3	20
Bleaching	0	0	0	0	0	5	0	0	0	0	5
Staining	0	0	0	0	0	5	0	0	0	0	5
Producing "limed" effects	0	0	0	0	0	5	0	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Painting continued											
Two-tone finishing	0	0	0	0	0	3	0	0	0	0	3
Graining effects	0	0	0	0	0	3	0	0	0	0	3
Flock finishes											
Finishing masonry products and concrete	5	0	5	0	0	5	0	0	0	0	15
Rubbing down and waxing	0	5	0	0	0	5	0	0	0	0	10
SPECIAL PROCEDURES											
Anti-corrosion finishes	5	3	5	5	5	5	0	5	5	5	43
Creation of special effects (variety of color, light reflecting, etc.)											
Decorative techniques (marbleizing, glazing, stippling, antique finish)	0	0	0	0	0	5	0	0	0	0	5
Water-proofing	5	5	5	5	5	5	5	5	5	5	50
METHODS OF DRYING	3	3	3	3	3	5	3	3	0	3	29

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Painting continued *COLOR AND ITS APPLICATION*	3	3	3	5	5	5	3	5	0	5	37
APPLICATION OF PRESSURE-SENSITIVE TAPES AND SURFACES	0	3	0	5	3	5	0	5	0	5	26
PLASTERING *INSPECTING THE JOB*											
Lathing operation	0	5	0	0	0	0	5	0	0	0	10
Type and grade of material used	0	3	0	0	0	0	5	0	0	0	8
Grounding conditions	0	3	0	0	0	0	5	0	0	0	8
Reinforcement of natural stress and strain	0	3	0	0	0	0	5	0	0	0	8
General construction of the building	3	5	0	3	0	3	5	3	3	3	28
CONDITIONING MASONRY AND CONCRETE BASES											
Using special bonding plasters	0	0	0	0	0	0	5	0	0	0	5
Washing concrete and masonry surfaces with acid	5	0	5	0	0	0	0	0	5	0	15

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plastering continued											
Condensation prevention	5	5	0	0	0	3	5	3	3	3	27
Waterproofing materials for concrete and masonry	5	3	5	0	0	3	5	0	3	0	24
Overcoating and patching old plaster	0	3	0	0	0	3	5	0	0	0	11
MIXING PLASTER											
Processing of gypsum											
Various types of plasters and their uses	0	3	0	0	0	3	5	0	0	0	11
Correct and careful proportioning of plaster ingredients	0	0	0	0	0	0	5	0	0	0	5
Purpose and proper use of accelerators and retarders	5	0	5	0	0	0	5	0	0	0	15
Processing of lime	5	0	0	0	0	0	5	0	0	0	10
A.S.T.M. requirements for plastering ingredients and mixtures											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plastering continued											
APPLYING THE SCRATCH COAT											
Laying the scratch coat on all types of bases	3	3	3	0	0	0	5	0	0	0	14
Proper curing of plaster	0	3	0	0	0	3	5	0	0	0	11
Using prepared plaster	0	0	0	0	0	0	5	0	0	0	5
Using portland cement plaster	0	0	0	0	0	0	5	0	0	0	5
THE BROWN COAT OF PLASTER											
Conditioning of the scratch coat to receive the brown coat	0	0	0	0	0	0	5	0	0	0	5
Characteristics of a good brown coat mixture	0	0	0	0	0	0	5	0	0	0	5
Common practiced methods of squaring the room, leveling beams, straightening ceilings and other horizontal areas	0	0	0	0	0	0	5	0	0	0	5
Running of screeds	0	0	0	0	0	0	5	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plastering continued											
Applying and straightening the brown coat on curved and difficult surfaces	0	0	0	0	0	0	5	0	0	0	5
FINISHING INTERIOR AND EXTERIOR PLAIN PLASTER											
Applying all types of finish coats	0	0	0	0	0	0	5	0	0	0	5
Procedures necessary for attaining the various finish textures	0	0	0	0	0	0	5	0	0	0	5
Materials used in finishing	0	0	0	0	0	0	5	0	0	0	5
Gauging plasters used in white coat finishes	0	0	0	0	0	0	5	0	0	0	5
Causes of finish coat failures	0	0	0	0	0	0	5	0	0	0	5
Application of accoustical plaster	0	0	0	0	0	0	5	0	0	0	5
Using plasticizers and mineral pigments	0	0	5	0	0	0	5	0	0	0	10
Applying and floating a common sand float finish	0	0	5	0	0	0	5	0	0	0	10

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plastering continued											
Dashing and the procedures for jointing and tuck pointing	0	0	0	0	0	0	5	0	0	0	5
MAKING TEMPLATES AND MOULDS											
Laying out geometric designs											
Construction and use of pressed screed templates and reverse templates	0	0	0	0	0	0	5	0	0	0	5
Laying out and construction of templates for vaulted, domed and groined ceilings	0	0	0	0	0	0	3	0	0	0	3
Construction of lunettes	0	0	0	0	0	0	3	0	0	0	3
Construction of molds (twin slipper, hanging, soffit, etc.)	0	0	0	0	0	0	5	0	0	0	5
Developing raking molds	0	0	0	0	0	0	5	0	0	0	5
INTERIOR ORNAMENTAL PLASTERING											
Setting wall screeds, slipper strip, ceiling dots and screeds	0	0	0	0	0	0	5	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plastering continued											
Furring out cornices and mouldings	0	0	0	0	0	0	5	0	0	0	5
Running cornices and mouldings	0	0	0	0	0	0	5	0	0	0	5
Running circular mouldings	0	0	0	0	0	0	5	0	0	0	5
Running niches and wall panels	0	0	0	0	0	0	5	0	0	0	5
Running ornamental ceilings	0	0	0	0	0	0	5	0	0	0	5
BENCH RUNNING AND PLANTING											
Building up the core											
Laying out, cutting and sticking moulding and cornice in place	0	0	0	0	0	0	5	0	0	0	5
Sticking and planting enrichments	0	0	0	0	0	0	3	0	0	0	3
Laying out and producing columns, pillars, and pilasters											
ESTIMATING											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plastering continued											
Calculating areas and materials quantities	0	0	0	0	0	0	5	0	0	0	5
Preparing the take-off	0	0	0	0	0	0	3	0	0	0	3
PLUMBING											
PRINCIPLES OF CITY SANITATION											
Water consumption and supply	0	0	0	0	0	0	0	5	0	0	5
Sewage disposal methods	0	0	0	0	0	0	0	5	0	0	5
BACTERIOLOGY OF PLUMBING											
Pathogenic organisms											
Water testing techniques	0	0	0	0	0	0	0	3	0	0	3
Methods of elimination	0	0	0	0	0	0	0	3	0	0	3
Sewer gas	0	0	0	0	0	0	0	3	0	0	3
Anaerobic bacteria											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plumbing continued *PRINCIPLES OF DRAINAGE AND VENTILATION WORK*											
Cutting standard and extra heavy cast iron pipe	0	0	0	0	0	0	0	5	0	0	5
Operation and care of the plumber's furnaces	0	0	0	0	0	0	0	5	0	0	5
Caulking horizontal and vertical cast iron joints	0	0	0	0	0	0	0	5	0	0	5
Cutting, reaming, threading and bending wrought iron pipe	0	0	0	5	5	0	0	5	0	0	15
Making up screw pipe work	0	0	0	0	0	0	0	5	0	0	5
Rough-in work (drains, ground lines, soil stacks, ventilation) for Durham work, small residential structures and multi-level or multi-unit structures	0	3	0	0	0	0	0	5	0	0	8
Layout of house sewer	0	3	0	0	0	0	0	5	0	0	8

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plumbing continued											
Venting a battery of lavatories	0	3	0	0	0	0	0	5	0	0	8
Testing a roughing-in	0	0	0	0	0	0	0	5	0	0	5
INSTALLATION OF FIXTURES											
Water meter	0	3	0	0	0	0	0	3	0	0	6
Lawn faucet	0	3	0	0	0	0	0	5	0	0	8
Refrigerator drain	0	3	0	0	0	0	0	5	0	0	8
Sink	0	3	0	0	0	0	0	5	0	0	8
Laundry tray	0	3	0	0	0	0	0	5	0	0	8
Lavatory	0	3	0	0	0	0	0	5	0	0	8
Bathtub	0	3	0	0	0	0	0	5	0	0	8
Water closet	0	3	0	0	0	0	0	5	0	0	8
Drinking fountain	0	3	0	0	0	0	0	5	0	0	8

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Nct essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plumbing continued											
Flush valves	0	0	0	0	0	0	0	5	0	0	5
Connecting to city water main	0	0	0	0	0	0	0	3	0	0	3
Fabrication of connections in brass and copper pipe and tubing	0	0	0	3	0	0	0	5	0	0	8
Bending brass and copper pipe and tubing	0	0	0	3	0	0	0	5	0	0	8
Roughing-in water supply lines	0	0	0	0	0	0	0	5	0	0	5
Range boiler and gas heater	0	0	0	0	0	0	0	5	0	0	5
SPECIAL INSTALLATION TECHNIQUES											
Garage, cellar or other special floor drains	0	3	3	0	0	0	0	5	0	0	11
Batteries of showers and urinals	0	0	3	0	0	0	0	5	0	0	8
Vacuum cleaner systems	0	3	0	0	0	0	0	5	0	0	8
Filters	0	0	0	0	0	0	0	5	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plumbing continued											
Water supply systems	0	0	0	0	0	0	0	5	0	0	5
Rust preventors	0	0	0	0	0	0	0	5	0	0	5
Sewer ejectors	0	0	0	0	0	0	0	5	0	0	5
Swimming pool equipment	0	0	0	0	0	0	0	5	0	0	5
Bidets	0	0	0	0	0	0	0	3	0	0	3
Hydraulic rams	0	0	0	0	0	0	0	3	0	0	3
LEAD WORKING PROCEDURES											
Heating, forging, and tinning a soldering iron	0	0	0	3	0	0	0	3	0	5	11
Tinning soldering nipples	0	0	0	0	0	0	0	3	0	5	8
Cup joints	0	0	0	0	0	0	0	5	0	0	5
Soldering flat and angle seams	0	0	0	0	0	0	0	5	5	5	15
Lead drum traps	0	0	0	0	0	0	0	3	0	0	3

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plumbing continued											
Capping lead bends	0	0	0	0	0	0	0	5	0	0	5
Sheet lead roof flashings	0	0	0	0	0	0	0	5	5	0	10
Hidden joints	0	0	0	0	0	0	0	5	0	0	5
Soldering overcast joint-block tin pipe	0	0	0	0	0	0	0	3	0	3	6
Soldering brass bushings to lead waste	0	0	0	0	0	0	0	3	0	0	3
Wiping solder composition, care and cleaning	0	0	0	3	0	0	0	5	0	0	8
Wiping cloths	0	0	0	0	0	0	0	5	0	0	5
Preparing and wiping flanges, horizontal, round and vertical joints	0	0	0	0	0	0	0	5	0	0	5
Bending lead pipe	0	0	0	0	0	0	0	5	0	0	5
Branch joints	0	0	0	0	0	0	0	5	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plumbing continued											
Wiping angles and flat seams	0	0	0	0	0	0	0	5	0	0	5
Beating up corners on sheet lead	0	0	0	0	0	0	0	5	0	0	5
Wiping lead to brass connections	0	0	0	0	0	0	0	3	0	0	3
Lead work in a residence	0	3	0	0	0	0	0	3	3	0	9
DOMESTIC GAS AND WATER SUPPLY INSTALLATION											
City cold water systems	0	3	0	0	0	0	0	5	0	0	8
Hot water supply systems in large buildings and residential structures	0	0	0	0	0	0	0	5	0	0	5
Return hot water circulation systems	0	0	0	0	0	0	0	5	0	0	5
Pneumatic cold water system	0	0	0	0	0	0	0	5	0	0	5
Hard and soft water system	0	0	0	0	0	0	0	5	0	0	5
Hot water tank, automatic storage system	0	0	0	0	0	0	0	5	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Plumbing continued											
Ice water system	0	0	0	0	0	0	0	5	0	0	5
Salt water system and swimming pool installation	0	0	0	0	0	0	0	5	0	0	5
Hot water incinerator system	0	0	0	0	0	0	0	5	0	0	5
Acetylene gas system	0	0	0	0	0	0	0	5	0	0	5
Gasoline pumps	0	0	0	0	0	0	0	5	0	0	5
ROOFING *METHODS AND PROCEDURES USED IN ROOF INSTALLATION*											
Application of tar, pitch, asphalt or other bituminous material	0	3	0	3	0	0	0	3	5	0	14
Flashing and trim installation	0	0	0	0	0	0	0	3	5	5	13
Application of sheet metal roofs (aluminum, corrugated iron	0	0	0	0	5	0	0	0	5	5	15

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Roofing continued											
Preparation of roof surface before covering	0	5	0	0	0	0	0	0	5	5	15
Gravel application	0	0	0	0	0	0	0	0	5	0	5
Application of tile roofs	0	3	0	0	0	0	0	0	5	0	8
Pitch limitations	0	5	0	0	5	0	0	0	5	5	20
Covering old roofing material	0	5	0	0	5	0	0	0	5	5	20
Gutter and down-spouts	0	3	0	0	0	0	0	0	5	5	13
Application of shingles (wood, asbestos, asphalt, etc.)	0	5	0	0	0	0	0	0	5	0	10
Application and arrangement of sheeting and decking	0	5	0	0	0	0	0	0	5	0	10
Application of built-up roofing	0	3	0	0	0	0	0	3	5	0	11
Building paper selection and application	0	5	0	0	0	0	0	0	5	0	10

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Roofing continued											
Application of roll roofing	0	3	0	0	0	0	0	0	5	0	8
METHODS AND PROCEDURES USED IN MOISTURE-PROOFING											
Preparation of surface	0	5	0	0	0	0	0	3	5	0	13
Application of water-proofing material	5	5	5	5	0	5	0	3	5	0	33
METHODS AND PROCEDURES USED IN ROOF REPAIR	0	0	0	0	0	0	0	0	5	0	5
TYPES OF ROOFS											
Residential	0	0	0	0	0	0	0	0	5	0	5
Industrial	0	0	0	0	0	0	0	0	5	0	5
ROOF FRAMING METHODS	0	5	0	0	0	0	0	0	5	0	10
SHEET METAL											
BASIC FABRICATION TECHNIQUES											
Soldering	0	0	0	5	5	0	0	5	5	5	25

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Sheet metal continued											
Riveting seaming	3	0	0	3	5	0	0	3	3	5	22
Locks: cleats	3	0	0	3	3	0	0	0	3	5	17
Stiffeners	3	0	0	3	3	0	0	0	3	5	17
Anchoring devices	3	3	3	5	5	0	0	5	3	5	32
Sheet metal screws and nails	5	5	0	5	5	0	0	5	5	5	35
Wire edges	0	0	0	0	3	0	0	0	0	5	8
Flanging	0	0	0	3	5	0	0	0	3	5	16
PRINCIPLES OF "RECTANGULAR" LAYOUT AND FABRICATION (PANS, ELBOWS, TRANSITION JOINTS "Y" BRANCHES, DUCT, TEE'S, ETC.)	0	0	0	3	5	0	0	0	0	5	13
PRINCIPLES OF "ROUND AND CONICAL" LAYOUT AND FABRICATION (HOODS, ELBOWS, TEE'S, "Y" BRANCHES, OFFSET SQUARE TO ROUND, ETC.)	0	0	0	0	5	0	0	0	0	5	10
SPECIAL LAYOUT AND FABRICATION METHODS (INCLUDING INSTALLATION AND ERECTING PROCEDURES)											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Sheet metal continued											
Plastic fabrication methods	3	3	0	5	5	0	0	5	3	5	29
Conductor heads	0	0	0	0	0	0	0	0	0	3	3
Louvers	3	3	0	3	5	0	0	3	3	5	25
Expansion joints	3	0	0	5	5	0	0	5	3	5	26
Ship ventilators	0	0	0	3	5	0	0	3	0	5	16
Skylights: plastic, metal	0	3	3	0	0	0	0	0	5	5	16
Kitchen hoods and canopies	0	3	0	3	0	0	0	0	0	5	11
Bay window canopies	3	3	0	0	3	3	0	0	0	3	15
Fume exhause hoods: plastic, metal	0	0	0	5	5	0	0	0	3	5	18
Collectors, cyclone	0	3	0	3	5	0	0	0	3	5	19
Spiral chutes	0	0	0	0	5	0	0	0	0	5	10
Store fronts	5	5	0	3	5	0	0	0	3	5	26

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Sheet metal continued											
Spray booths, ovens (industrial)	0	0	0	5	5	0	0	0	0	5	15
Plenums--fan housings	3	3	0	3	3	0	0	3	3	5	23
Metal ceilings	0	3	0	3	3	0	0	0	0	5	14
Lockers	0	0	0	3	3	0	0	0	0	5	11
Curtain walls	0	3	0	0	3	0	0	0	0	5	11
Decking	3	3	0	3	5	0	0	0	5	5	24
Metal buildings	0	3	0	3	5	0	0	0	3	5	19
Cornices	0	3	0	0	3	0	0	0	0	5	11
Facia	0	3	0	0	3	0	0	0	0	5	11
INSTALLATION AND SERVICING OF AIR HANDLING EQUIPMENT											
Principles of basic electricity (basic)	0	3	0	5	0	0	0	0	0	5	13
Controls: electronic (how operating)	0	0	0	5	0	0	0	3	0	3	11

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Sheet metal continued											
Controls: pneumatic (how operated and function)	3	3	3	3	0	0	0	0	0	3	15
Burners: oil	0	0	0	5	3	0	0	0	0	5	13
Burners: gas	0	0	0	5	3	0	0	0	0	5	13
Fans	3	3	0	5	3	0	0	3	0	5	22
Blowers	0	0	0	5	5	0	0	0	0	5	15
Combustion, air and venting	0	0	0	3	3	0	0	3	3	5	17
Testing and balancing procedures	0	0	0	0	0	0	0	0	0	5	5
WELDING											
WELDING THEORY AND PRACTICE											
Oxy-acetylene welding	5	5	0	5	5	0	0	5	5	5	35
Electric arc (AC-DC) welding	5	5	0	5	5	0	0	5	5	5	35
Resistance welding	0	0	0	5	5	0	0	0	0	5	15

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Sheet metal continued											
Heli-arc welding	0	0	0	0	0	0	0	0	0	5	5
Soldering and brazing	0	0	0	5	0	0	0	5	5	5	20
Non-ferrous welding	0	0	0	5	0	0	0	5	0	5	15
Pipe and tube welding	0	0	0	5	5	0	0	5	0	5	20
Cast iron welding	0	0	0	0	0	0	0	5	0	0	5
Special ferrous metal welding (low carbon alloy steel, stainless steel, chrome)	0	0	0	0	5	0	0	5	0	5	15
Cutting (oxy-acetylene, arc)	5	5	5	5	5	0	0	5	5	5	40
Heat treating - hard surfacing											
New welding processes (cold welding, ultra-sonic welding, rocket metal spraying, new electrodes)	0	0	0	0	0	0	0	5	0	5	10
Positions and types of joints	5	5	0	5	5	0	0	5	5	5	35

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Sheet metal continued											
Flame characteristics	5	5	0	5	5	0	0	5	5	5	35
Production methods (metal)	0	0	0	0	5	0	0	0	0	5	10
INSPECTION AND TESTING WELDS											
Shop methods (destructive, comparison, etc.)											
Laboratory methods (tensile ductility method, **hardness** method, microscopic method, chemical analysis method, magnetic flux test, lime coating test, X-ray air pressure test, and stethoscope test)											
PROPERTIES OF METALS											
Heat transfer	5	3	3	5	5	0	0	5	5	5	36
Expansion and contraction	5	3	3	5	5	0	0	5	5	5	36
Identification tests (spark, oxy-acetylene torch, chemical)	0	0	0	0	5	0	0	0	0	5	10

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Sheet metal continued											
Color codes	0	0	0	0	5	0	0	3	3	5	16
A.W.S. numbering system	5	5	0	5	5	0	0	5	5	5	35
Alloy metals	3	3	0	3	5	0	0	5	3	5	27
Crystalline structure	3	3	0	3	3	0	0	3	3	3	21
Tempering and annealing characteristics	3	3	0	3	3	0	0	3	3	3	21
Electrical conduction characteristics	3	3	0	3	3	0	0	3	3	3	21
GENERAL KNOWLEDGE											
RIGGING, HOISTING											
Principles of levers	5	5	3	5	5	5	3	5	5	5	46
Principles of pulleys	5	5	3	5	5	5	3	5	5	5	46
Gin poles	3	5	0	5	5	5	3	5	0	3	34
Block and tackle--chain hoists, winches	3	5	3	5	5	5	3	5	5	5	44

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Knots and hitches	5	5	0	5	5	5	3	5	5	5	43
Boatswain chair	3	5	0	5	5	5	3	3	0	5	34
Signals	3	5	3	5	5	5	3	5	5	3	42
SCAFFOLDING: TYPES AND METHODS OF CONSTRUCTING OR ERECTING	5	5	0	3	5	5	5	3	5	3	39
SAFETY PRACTICES											
Lifting heavy objects	5	5	5	5	5	5	5	5	5	5	50
Protection of eyes	5	5	5	5	5	5	5	5	5	5	50
Protection against dust, obnoxious fumes, gases	5	5	5	5	5	5	5	5	5	5	50
Handling of materials: lumber, metal, etc.	5	5	5	5	5	5	5	5	5	5	50
Work clothes	5	5	5	5	5	5	5	5	5	5	50

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued *BLUEPRINT READING*											
Views	5	5	0	5	5	0	0	5	5	5	35
Scales and dimensions	5	5	0	5	5	0	0	5	0	5	30
Vocabulary of lines	5	5	0	5	5	0	0	5	0	5	30
Sections and details	5	5	0	3	5	0	0	5	0	5	28
Symbols and conventions	5	5	0	5	5	0	0	5	0	5	30
Structural (wood)	5	5	0	5	5	0	0	5	0	5	30
Structural (metal)	5	5	0	5	5	0	0	5	0	5	30
Structural (masonry)	5	5	0	5	5	0	0	5	0	5	30
Welding	5	5	0	5	5	0	0	5	0	5	30
Plumbing	5	3	0	3	5	0	0	5	0	5	26
Electrical	5	3	0	5	5	0	0	3	0	5	26

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Sheet metal	5	3	0	3	5	0	0	3	0	5	24
Types of plans	3	5	0	3	5	0	0	5	0	5	26
Plot	3	5	0	3	5	0	0	3	0	5	24
Foundation	3	5	0	0	5	0	0	5	0	5	23
Floor	3	5	3	3	5	3	0	5	0	5	32
Elevations	3	5	0	5	5	3	0	5	3	5	34
Sections	3	5	0	5	5	3	0	5	0	5	31
Working	3	5	0	5	5	3	0	5	0	5	31
Structural	3	5	0	3	5	3	0	3	0	5	27
Roof	3	5	0	3	5	3	0	3	5	5	32
Heating, ventilating, air conditioning	3	3	0	3	5	0	0	3	0	5	22
Plumbing	3	3	0	3	5	0	0	5	0	5	24

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Electrical	3	3	0	5	5	0	0	3	0	5	24
Sprinkler	3	3	0	3	5	0	0	5	0	5	24
Communications: telephone, intercom	3	3	0	5	5	0	0	3	0	5	24
PRINCIPLES OF DRAWING (SKETCHING)											
Orthographic drawing	5	5	0	5	5	3	0	5	0	5	33
Isometric drawing	0	5	0	3	5	0	0	5	0	5	23
Oblique drawing	0	5	0	0	5	0	0	5	0	0	15
Perspective drawing	0	3	0	0	3	0	0	3	0	5	14
Shading	5	0	0	0	3	0	0	3	0	5	16
Working drawings	0	3	0	3	5	0	0	3	0	5	19
Placement of views	0	5	0	3	5	0	0	3	0	5	21
Dimensioning working drawings	0	5	0	3	5	0	0	3	0	5	21

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Circles, arcs and center lines	0	5	0	3	5	0	0	3	0	5	21
Types, use and care of drawing instruments	0	0	0	0	5	0	0	3	0	5	13
Principles of pattern development	0	0	0	0	5	0	0	5	0	5	15
Lateral surface development (patterns)	0	3	0	0	5	0	0	5	0	5	18
Sketching methods	5	5	0	5	5	0	0	5	5	5	35
SPECIFICATIONS AND SCHEDULES											
General	5	5	5	5	5	3	3	5	0	5	41
Sheet metal	5	3	0	3	5	3	3	5	3	5	34
Plumbing	5	3	0	3	5	3	3	5	0	5	32
Electrical	5	5	0	5	5	3	3	5	0	5	36
Concrete	5	5	5	3	5	3	3	0	0	5	34
Masonry	5	5	3	3	5	3	3	0	0	5	32

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Roofing	5	5	0	0	5	0	0	0	5	5	25
Welding	5	3	0	5	5	0	0	5	0	5	28
COMMUNICATION PROCESSES AND EQUIPMENT											
Interests of audience: know what aspects of a matter are of most interest to the person you are talking to	3	3	3	3	3	3	3	3	0	0	24
Methods of obtaining facts and ideas: procedures for collecting information about a subject	3	5	3	5	5	5	3	3	0	5	37
Procedures for outlining major ideas: techniques of arranging facts and ideas in clear logical order	3	3	0	5	5	0	0	0	0	0	16
Sentence and paragraph structure: techniques for constructing easily understood sentences and paragraphs	5	5	0	3	3	0	0	3	0	0	19
Ways to interpret responses: ways of discovering if people understood what you say or write	0	0	0	0	5	0	0	5	0	0	10

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Graphic principles and techniques: principles of preparing effective charts, graphs, and pictures	3	5	0	3	3	0	0	5	0	5	24
Dictionaries and thesaureses: ways to use dictionaries and lists of synonyms	3	3	0	0	0	0	0	5	0	0	11
Handbooks, manuals, catalogues: familiarity with commonly used handbooks, manuals and catalogues	5	5	0	5	5	5	0	5	0	5	35
Communication equipment, telephone, teletype: how to use effectively	5	5	3	5	5	5	0	5	0	5	38
Specialized vocabulary: technical words and phrases commonly used in your occupation	5	5	5	5	5	5	5	5	5	5	50
Technical report writing techniques: outlines, forms, phrases symbols and statistics commonly used in the preparation of reports	3	3	3	3	3	3	0	5	0	3	26
BASIC MATHEMATICS											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Arithmetic of the integers: addition, subtraction, multiplication, and division of whole numbers	5	5	3	5	5	5	5	5	5	5	48
Order properties of the integers: relative values and relationships of whole numbers	5	5	3	5	5	5	5	5	5	5	48
FRACTIONS, DECIMALS, PERCENTAGE											
Arithmetic operations with fractions: addition, subtraction, multiplication and division of fractions	5	5	3	5	5	5	3	5	3	5	44
Arithmetic operations with decimals: addition, subtraction, multiplication, and division of decimals	5	5	3	5	5	3	3	3	3	5	40
Conversion: fraction - decimal: changing values from one form to the other	3	5	3	5	5	3	3	5	3	5	40
Order properties of fractions and decimals: relative values and relationships of fractions and decimals	3	3	3	5	5	3	3	3	3	5	36

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
The concept of percent: the meaning of percentage; where and how it is used	3	3	3	5	5	3	3	3	3	5	36
Base of percentage: determining what amount should equal 100%	0	3	0	3	3	0	0	3	0	5	17
Rate of change: calculation of the % of change	5	5	3	3	5	3	0	5	5	5	39
Concept of ratio and proportion: expression of the relative values of quantities	5	[illegible]	5	5	3	5	5	5	3	5	46
ALGEBRA											
Concept of literal representation: substitution of letters for unknown values	0	0	0	5	3	0	0	0	0	0	8
Arithmetic principles of operations on algebraic quantities: addition, subtraction, multiplication, and division involving algebraic quantities											
Associative: (a + b) + c = a + (b + c)											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued Communitative: a + b = b + a											
Distributive: a . (b + c) = (a . b) + (a . c) (Note: the above three may be used to check results of addition, multiplication, subtraction, and division problems.)											
Arithmetic of signed quantities: manipulation of + and/or - quantities											
Translation of problems into algebraic notation: stating a word problem with algebraic symbols											
Solution of equations: finding values of unknown letters (terms)											
Degree 1: equations involving the first power, eg., $X + 3 = 4$											
Degree 2: equations involving the second power, eg., $X^2 + 3 = 4$											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Degree greater than 2 equations involving power greater than second, eg., $X^2 = 2$											
Simultaneous linear equations:finding the values of more than one unknown letter (term by manipulation of more than one equation involving these terms)											
Calculation of square roots: finding a number when multiplied by itself will equal the given value	0	0	0	0	5	0	0	0	0	0	5
Concepts of exponents and/or logarithms											
Conversions from logarithms to exponents and visa versa											
Solution of logarithms equations											
Graphing logarithmic and/or exponential functions											
Graphing polynomial functions											
Calculation with logarithms											
GEOMETRY AND MEASUREMENTS											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Knowledge of the concept of a line, plane, angle, closed figure	3	5	3	3	5	5	3	5	5	5	42
Knowledge of special polygons: knowledge of distinguishing characteristics such as total degrees in all angles, number of sides, etc., of such figures as squares, triangles, rectangles, etc.	3	5	0	3	5	0	0	5	0	5	26
Basic geometric constructions: ability to bisect angles and lines: construct perpendiculars, lay off equal length lines, divide a line into equal parts, etc.	3	5	0	3	5	0	0	5	0	3	24
Concept of congruence: figures that are the same size and shape	3	5	3	3	5	3	3	3	3	3	34
Concept of symmetry: similar shape on either side of center lines	3	5	3	3	5	3	3	3	3	3	34
Graphs											
Construction: placing fact on a form that relates them by means of scales											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Interpretation: reading and understanding information presented in graph form	3	3	3	5	5	3	3	5	3	5	38
Measurement operations											
Unit conversion: changing from one unit to another such as from feet to inches	5	5	5	5	5	5	5	5	5	5	50
Linear measurement; dealing with lengths, widths, height or distance	5	5	5	5	5	5	5	5	5	5	50
Area of rectangular figures; finding size of surface of a rectangle or square	5	5	5	5	5	5	5	5	5	5	50
Area of figures containing circles: finding the size of a circular surface	5	5	5	5	5	5	5	5	5	5	50
Angular measures: number of degrees in an angle	5	5	0	5	5	0	0	5	0	5	30
Volume of rectangular solids	3	3	0	5	5	0	0	5	0	5	26
Volume of spherical solids	0	3	0	0	5	0	0	5	0	5	18

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Calculate weights of objects	3	3	0	5	5	0	0	5	0	5	26
TRIGONOMETRY											
Solution of right triangles; finding the length of one side when the other two are known	0	3	0	3	0	0	0	3	0	3	12
Concept of trigometric function; sime, cosine, tangent, contangent											
Determining numerical values for functions											
Graphing trigometric functions											
Knowledge of period, amplitude, phase	0	0	0	5	0	0	0	0	0	0	5
VECTORS AND VECTOR ALGEBRA											
Vector representation											
Vector operations											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Addition and subtraction											
Multiplication and division											
Powers and roots											
Graphing vectors											
Translation of vectors to polar coordinates and visa versa											
Matrix operations											
Addition and subtraction											
Multiplication											
Solution of determinants											
Inverse of a matrix											
Characteristic equations and root											
PROBABILITY AND STATISTICS											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Permutations and combinations											
Probability functions											
Binomial distribution											
Porsson distribution											
Normal distribution											
t-distribution											
Chi-square distribution											
Gamma distribution											
f-distribution											
Hypothesis testing											
Prediction											
CALCULUS											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Differentiation											
Tangents and normals											
Rate of change problems											
Maximum and minimum											
Integration											
Determining areas and volumes											
Moments of inertia											
Numeric methods											
Sequences and series											
Differential equations											
Laplace transforms											
MISCELLANEOUS											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Coding: arrangement of items in regard to a numbering system	3	3	0	5	5	0	0	5	0	0	21
Time calculation concepts (i.e., scheduling): determining a relationship between time and activity)	3	3	3	5	5	3	3	5	5	5	40
Use of slide rule	0	0	0	5	5	0	0	0	0	3	13
Use of tables, such as in handbooks	5	5	5	5	5	5	5	5	5	5	50
Making mental approximations to calculations; figuring problems roughly in your head	5	5	5	5	5	5	5	5	5	5	50
ESTIMATING TECHNIQUES											
General	5	5	5	5	5	5	5	5	5	5	50
Carpentry	3	5	0	0	5	0	0	0	0	0	13
Masonry	5	3	0	0	5	0	0	0	0	0	13
Electrical	0	3	0	5	0	0	0	0	0	0	8

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Concrete	3	3	5	0	5	0	0	0	0	0	16
Plumbing	0	3	0	0	0	0	0	5	0	0	8
Sheet metal (heating, ventilating, air conditioning)	0	0	0	0	5	0	0	0	0	5	10
WORKMAN COMPENSATION	3	3	3	3	3	3	3	3	3	3	30
HEALTH AND WELFARE LAWS AND AGREEMENTS	3	3	3	3	3	3	3	3	3	3	30
SOCIAL SECURITY AND PENSIONS	3	3	3	3	3	3	3	3	3	3	30
TAXES, DEDUCTIONS: VOLUNTARY AND COMPULSORY	3	3	3	3	3	3	3	3	3	3	30
VACATIONS AND HOLIDAYS	3	3	3	3	3	3	3	3	3	3	30
APPRENTICESHIP CONTRACTS AND STANDARDS	3	3	3	3	3	3	3	3	3	3	30
BONDING AGREEMENTS	3	3	3	3	3	3	3	3	3	3	30
LABOR MANAGEMENT CONTRACTS	3	3	3	3	3	3	3	3	3	3	30
SENIORITY AND JOB ADVANCEMENT	3	3	3	3	3	3	3	3	3	3	30

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued *KNOWLEDGE OF MATERIALS, FIXTURES, AND APPLIANCES: TYPES AND USES*											
Acoustic materials	0	5	5	3	5	0	5	5	5	5	38
Adhesives: glue, cement epoxy, etc.	5	5	5	5	5	5	5	5	5	5	50
Abrasives	5	5	5	5	5	5	0	5	0	5	40
Aggregates: sand, gravel, crushed rock, etc.	5	5	5	0	5	0	5	5	5	3	38
Appliances: ranges, refrigerators, dishwashers, etc.	0	5	0	0	0	0	0	5	0	3	13
Asbestos materials	5	5	0	5	5	0	5	5	5	3	38
Cabinets: factory built; metal, wood, plastic	0	5	0	0	3	5	0	5	0	3	21
Canvas (sheet metal)	0	0	0	0	0	5	0	0	0	3	8
Caulking materials	5	5	5	5	5	5	5	5	5	5	50

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Conductors: electric, heat	5	5	5	5	3	0	5	5	5	0	38
Conduits and conduit fittings	0	5	5	5	0	0	5	3	0	0	23
Doors and door frames	5	5	5	0	5	5	5	3	0	5	38
Dry wall covering	3	5	5	3	0	5	5	3	0	0	29
Duct and raceway materials (electricity)	0	0	0	5	5	0	0	5	0	5	20
Electrical components: switches, outlets, relays, etc.	0	5	0	5	0	0	0	3	0	0	13
Fasteners: nails, screws, bolts, staples, heavy timber, fasteners, etc.	5	5	0	5	5	3	0	5	5	5	38
Fixtures: bathroom, fans, etc.	0	5	0	3	5	0	0	3	0	5	21
Fixtures: lighting, heating	0	5	0	5	5	0	0	3	0	5	23
Flooring materials: linoleum, vinyl, asphalt, cork, etc.	0	5	5	0	0	0	5	3	0	0	18
Glass and glazing supplies	5	5	0	0	5	5	0	5	3	5	33

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Hardware: hinges, catches, locks, etc.	0	5	0	3	5	3	0	5	0	5	26
Heating equipment: furnaces, boilers, etc.	5	3	0	3	0	0	0	5	0	5	21
Insulation, building: batts, rolls, etc.	5	5	3	3	5	0	5	5	5	5	41
Insulation, electric: tapes, liquids, etc.	5	5	0	5	0	0	0	0	0	0	15
Lumber, dimension	5	5	5	5	5	0	0	5	5	5	40
Lumber, finish: moulding, siding, etc.	0	5	0	0	0	0	0	5	5	0	15
Masonry products: brick, concrete block, fire brick, tile, etc.	5	5	0	3	5	0	0	5	0	0	23
Mortar ingredients: lime, portland cement, etc.	5	5	5	0	5	0	5	5	0	0	30
Metals: sheet, plates, extruded, angles, hardware cloth, etc.	3	5	0	3	5	5	0	5	3	5	34
Paints and finishes: including thinning and cleaning materials	0	5	0	3	5	5	5	3	5	5	36

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Panels, electrical	0	3	0	5	5	0	0	5	0	0	18
Pipe and pipe fittings	0	3	0	3	5	0	0	5	0	5	21
Plaster and plaster materials	0	3	0	0	0	0	5	5	0	5	18
Plaster board (sheet rock)	0	5	0	0	0	0	5	5	0	5	20
Plastics: wire, cloth, screen, sheet, tubing	0	5	0	5	0	0	0	5	3	5	23
Plastic laminates	0	5	0	0	5	5	0	5	0	5	25
Plywood	0	5	0	5	5	3	0	5	5	5	33
Plumbing fixtures	0	5	0	0	5	0	0	5	0	0	15
Pre-cast masonry units	5	3	5	0	5	0	0	5	0	0	23
Reinforcing materials: mesh, ties, metal lath, rod, etc.	5	5	5	3	5	0	5	5	0	5	38
Roofing materials: tar, felt paper, shingles, gutters, downspouts, flashing, etc.	5	5	0	0	0	0	0	5	5	5	25

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Ropes and cables	5	0	0	3	5	3	0	3	5	3	27
Stone and slate	5	3	0	0	0	0	0	3	5	3	19
Timber, structural: laminated	0	5	0	0	5	0	0	3	0	0	13
Water conditioners	0	0	0	0	0	0	0	5	0	0	5
Water proofing materials	5	5	5	3	5	5	5	5	5	5	48
Welding supplies, arc	5	5	0	5	5	0	0	5	0	5	30
Welding supplies, gas	5	5	0	5	5	0	0	5	0	5	30
Welding fuels (gases)	5	5	0	5	5	0	0	5	0	5	30
Windows and window frames (wood and metal)	5	5	5	0	5	5	0	3	0	5	33
TOOLS, MACHINES, EQUIPMENT: TYPES AND USES AND CARE OF											
Acetylene generators	0	0	0	0	5	0	0	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Air compressors	3	5	5	5	5	5	5	5	5	5	43
Batteries	0	0	0	5	3	0	0	0	0	3	11
Benders, pipe	3	0	0	3	5	0	0	5	0	0	13
Benders, conduit	0	0	0	5	0	0	0	5	0	5	15
Boring tools, hand (wood): hand drills, reamers, braces, bits, etc.	5	5	5	5	5	3	5	5	5	5	48
Boring tools, hand (metal): hand drills, reamers, etc.	5	5	5	5	5	0	0	5	5	5	40
Buffers	5	0	3	3	5	5	0	5	0	5	31
Capacitance bridges	0	0	0	5	0	0	0	0	0	0	5
Checkers, substitution box	0	0	0	5	0	0	0	0	0	3	8
Caulking equipment	5	5	5	5	5	5	0	5	5	5	45
Concrete and mortar mixing hand tools: hoe, box, etc.	5	5	5	0	5	0	5	5	0	0	30

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Concrete finishing hand tools: float, darby, tamper, etc.	0	5	5	0	5	0	5	5	0	0	25
Crane or hoist (small, electric)	5	0	0	3	5	0	0	3	5	5	26
Cutting machine (sheet metal): sheer, etc.	0	0	0	3	5	0	0	0	5	5	18
Drill; power, portable	5	5	3	5	5	5	3	5	5	5	46
Drill: power, stationary	0	5	0	5	5	0	0	5	5	5	30
Drives, two-series motor	0	0	0	0	0	0	0	0	0	0	0
Electrical hand tools: side cutters, needle nose pliers	3	5	3	5	5	3	3	5	5	5	42
Fastening tools: hammers, axes, wrenches, pliers, screw drivers, nail sets	5	5	5	5	5	5	5	5	5	5	50
Float: power	0	3	5	0	0	0	5	0	0	0	13
Forge	0	0	0	0	5	0	0	3	0	3	11

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Forming tools (hand--sheet metal): groover, hand seamer, rivet sets, etc.	0	0	0	5	5	0	0	3	0	5	18
Fuel cells											
Gas torch or furnace	3	0	0	5	5	5	0	5	5	5	33
Generator, function	0	0	0	5	0	0	0	0	0	3	8
Generator, pulse											
Generator, signal - RF and audio	0	0	0	5	0	0	0	0	0	3	8
Grinding machines	5	5	0	3	5	0	0	5	0	5	28
Hard surfacing equipment: (welding)	0	0	0	0	5	0	0	0	0	0	5
Holding tools: "C" clamps, bar clamps, vise, pipe clamps, etc.	5	5	5	5	5	0	0	5	0	5	35
Impact power tools	5	5	3	5	5	0	0	5	3	5	25
Impedence bridges	0	0	0	3	0	0	0	0	0	0	3
Insulators	3	3	3	5	3	3	3	3	3	3	32

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Joint cutter	5	0	0	0	0	0	0	0	0	0	5
Jointer	0	5	0	0	0	0	0	0	0	0	5
Layout, measuring, marking and checking instruments (wood working): transit, plumb bob, tape, squares, etc.	5	5	5	5	5	5	5	5	5	5	50
Lathe; wood	0	3	0	0	0	0	0	0	0	0	3
Lathe; metal	0	0	0	3	3	0	0	0	0	5	11
Meggers	0	0	0	5	0	0	0	0	0	0	5
Meters: multi-meter, dynamometer, etc.	0	0	0	5	0	0	0	0	0	3	8
Meters: dynamometer	0	0	0	5	0	0	0	0	0	0	5
Meters: field strength	0	0	0	5	0	0	0	0	0	0	5
Meters: frequency	0	0	0	5	0	0	0	0	0	0	5
Meters: DC	0	0	0	5	0	0	0	0	0	3	8

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Meters; output	0	0	0	5	0	0	0	0	0	3	8
Meters: ph meters and megohmmeters	0	0	0	5	0	0	0	0	0	0	5
Meters: ammeters (including "clamp on")	0	0	0	5	0	0	0	0	0	3	8
Meters: voltameters	0	0	0	5	0	0	0	0	0	3	8
Meters; VTVM	0	0	0	5	0	0	0	0	0	3	8
Meters; gas	0	0	0	0	5	0	0	3	0	3	11
Meters: water	0	0	0	0	0	0	0	3	0	0	3
Meters: pressure	0	0	0	0	5	0	0	5	0	5	15
Meters: power factor	0	0	0	5	0	0	0	0	0	0	5
Meters: phase sequence											
Meters: watt-meter	0	0	0	3	0	0	0	0	0	3	6
Meters; tachometers	0	0	0	3	0	0	0	0	0	0	3
Meters; iron vane	0	0	0	5	0	0	0	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Mixer: power mortar	0	0	5	0	0	0	0	0	0	0	5
Mortiser	0	5	0	0	0	0	0	0	0	0	5
Motors; single-phase	3	3	0	5	3	0	0	3	0	3	20
Motors; gasoline	5	5	5	5	5	3	3	5	5	3	44
Motors; 3-phase	3	3	0	5	3	0	0	3	0	3	20
Motors; 3-phase synchronous	3	3	0	5	3	0	0	3	0	3	20
Multipliers	0	0	0	5	0	0	0	0	0	0	5
Nailing machine	0	5	0	5	5	0	0	0	3	0	18
Oscilloscopes: cathode-ray, sweep	0	0	0	5	0	0	0	0	0	0	5
Oxy-acetylene cutting torch	5	5	0	5	5	0	0	5	0	5	30
Oxy-acetylene welding equipment	5	5	0	5	5	0	0	5	0	5	30
Painting and finishing equipment: brushes, rollers, etc.	3	5	5	3	5	5	5	5	0	5	38

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Planer (surfacer); wood	0	5	0	0	0	0	0	0	0	0	5
Polishing tools, power (portable or fixed)	5	0	0	0	5	5	0	5	0	5	25
Portable power plane	0	5	0	0	0	0	0	0	0	5	10
Power actuated tools	5	5	5	5	5	0	0	5	0	5	35
Power pipe machine: threading, reaming, cutting	0	0	0	5	5	0	0	5	0	5	20
Pressure splicing tools: hand and power	0	0	0	5	5	0	0	0	0	0	10
Prying tools: nail pullers, wrecking bars, crow bars, etc.	5	5	5	5	5	5	5	5	5	5	50
Punches	0	5	0	5	5	0	0	5	0	5	25
Rectifier	0	0	0	5	0	0	0	0	0	0	5
Regulators: induction, voltage	0	0	0	5	0	0	0	0	0	0	5
Relays and AC contactors	0	0	0	5	3	0	0	0	0	3	11

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Repair tools: snake, plunger, etc.	0	0	0	3	5	0	0	5	0	0	13
Riveting equipment (tools)	0	5	0	5	5	0	0	0	0	5	20
Router; electric	0	5	0	3	0	0	0	3	0	3	14
Sand blasting equipment	5	0	5	0	5	5	0	3	0	3	26
Sanders; electric, fixed	0	5	0	0	5	5	0	0	5	5	25
Sanders: electric, portable	5	5	0	0	5	5	0	0	5	5	30
Saturable reactors											
Saw: band	0	5	0	0	5	0	0	0	0	5	15
Saw: circular	5	5	0	3	5	0	0	5	0	5	28
Saw; jig (scroll)	0	5	0	0	0	0	0	5	0	5	15
Saw: portable - "skill"	5	5	5	5	5	0	0	5	5	5	40
Saw: radial arm	3	5	0	3	5	0	0	5	0	5	26

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Saw: saber	0	5	0	5	5	0	0	5	5	5	30
Scraping tools: hand and power	0	5	0	5	5	5	0	5	5	5	35
Smooth facing tools: planes, scrapers	0	5	0	0	0	0	0	0	0	0	5
Shaper	0	5	0	0	0	0	0	0	0	0	5
Sharp edge cutting tools: hand: chisels, star drill, countersink, knives, tin snips	5	5	3	5	5	5	0	5	5	5	43
Shunts	0	0	0	5	0	0	0	0	0	0	5
Signal tracers	0	0	0	5	0	0	0	0	0	0	5
Soldering and brazing equipment	0	0	0	5	5	0	0	5	0	5	20
Spray gun and equipment	5	3	5	3	0	0	5	0	5	5	31
Stakes, sheet metal	0	0	0	0	5	0	0	0	0	5	10
Staplers	0	5	0	5	5	0	0	5	0	5	25

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Synchronoscopes	0	0	0	3	0	0	0	0	0	0	3
Tapping machines	0	0	0	3	5	0	0	0	0	3	11
Tar heater	0	0	0	0	0	3	0	3	5	5	16
Tenoning machine	0	5	0	0	0	0	0	0	0	0	5
Thermocouples	0	0	0	3	0	0	0	0	0	0	3
Threading machines	0	3	0	5	5	0	0	5	0	5	23
Tooth cutting tools, wood (hand): saws, files, rasps, etc.	0	5	3	5	5	0	0	5	5	5	33
Tooth cutting tools, metal (hand): saws, files, etc.	5	5	3	5	5	0	0	5	5	5	36
Tool sharpening equipment, (power): saw filers, etc.											
Tool sharpening equipment, (hand): files, oil stones, etc.	5	5	3	5	5	3	3	5	5	5	44

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
General continued											
Transit	0	5	5	5	5	0	5	5	5	5	40
Transformers	0	0	0	5	5	0	0	5	0	3	18
Trowels; power	0	0	5	0	0	0	5	0	5	0	15
Tube testers	0	0	0	5	0	0	0	0	0	0	5
Welding machines resistance	0	0	0	5	5	0	0	5	0	5	20
Turning machines	0	0	0	0	5	0	0	0	0	5	10
Welding machines, AC	5	5	0	5	5	0	0	5	0	5	30
Welding machines, DC	5	5	0	5	5	0	0	5	0	5	30
Welder; arc, inert gas	0	0	0	5	5	0	0	5	0	5	20
Welding machine, automatic	0	0	0	0	5	0	0	0	0	5	10
Welder, vacuum tube											
Welder, storage battery											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
SCIENCE Law of Conservation of Energy and/or matter; potential and kinetic energy											
Elastic properties of matter	3	3	3	3	3	0	0	3	0	3	21
Surface tension, capillarity	3	3	3	0	0	3	3	3	3	0	21
States of matter and their dependence on pressure and temperature	0	0	0	0	0	0	0	0	0	3	3
MECHANICS OF SOLIDS											
Scalars; vectors (and their addition)	0	3	0	0	3	0	0	0	0	0	6
Conditions of equilibrium	0	3	0	0	3	0	0	0	0	0	6
Inertia, translational and rotational	3	3	3	3	3	3	3	0	0	3	24
Gravitational attraction											
Laws of motion, uniformly accelerated motion, Newton's three laws											
Conservation of momentum											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Centrifugal and centripetal forces											
Principles of simple machines, principle of mechanical advantage	3	5	3	3	5	3	3	3	3	3	34
Friction											
MECHANICS OF LIQUIDS											
A fluid surface, at rest, lies in a horizontal plane	3	3	3	0	3	0	0	3	3	3	21
Pressure	3	5	5	3	3	3	3	5	3	5	38
Pascal's principle	0	3	3	0	0	0	0	3	0	0	9
Archimedes Principle, buoyancy											
Bernoullis Principle	0	0	0	0	0	0	0	0	3	0	3
Osmosis											
MECHANICS OF GASES											
Atmospheric pressure											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
General gas law											
Law of partial pressures											
Kinetic theory of gases											
HEAT											
Expansion due to heating	3	3	3	3	5	0	0	3	3	5	28
Coefficient of linear expansion	0	3	0	3	5	0	0	3	0	3	17
Conduction	0	3	0	3	3	0	0	3	0	3	15
Convection	0	0	0	5	0	0	0	0	3	5	13
Radiation, what its properties are	0	0	0	5	3	0	0	0	0	3	11
Heat capacity	3	3	3	3	3	0	0	3	0	3	21
States of matter, Ht of fusion, Ht of vaporization	0	0	0	0	0	0	0	0	0	3	3
boiling point and freezing points, effects of dissolved substances, etc.	0	3	0	3	0	0	0	0	0	3	9

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Relative humidity	0	3	0	3	0	3	3	0	3	0	15
Vapor pressure											
Kindling temperature	0	0	0	0	0	0	0	3	3	0	6
SOUND											
Transmission through matter	0	3	0	0	3	0	0	0	0	0	6
Wave motion, Huygens Principle, amplitude, frequency, period, wave form, resonance, interference											
Wave velocity											
Reflection, echo											
Sound properties, loudness, quality, pitch											
Doppler effect											
Vibrations of strings, rods, air columns, resonance											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
LIGHT											
Properties of light waves											
Index of refraction											
Inverse square law	0	0	0	3	0	0	0	0	0	0	3
Laws of reflection											
Laws of refraction and total reflection											
Dispersion											
Electromagnetic spectrum, color	0	0	0	0	3	0	0	0	0	0	3
Spectroscopy											
Principles of optical instruments, f value, focal length, etc.	0	3	0	0	3	0	0	0	0	0	6
Polarization											
MAGNETISM											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Magnetic materials	0	3	0	3	3	0	0	0	0	0	9
Magnetic attraction and repulsion	0	3	0	3	3	0	0	0	0	0	9
Magnetic field set up by an electric current	0	0	0	3	0	0	0	0	0	0	3
Magnetic force on a current carrying wire											
STATIC ELECTRICITY											
Nature of an electric charge, its atomic origin											
Force due to electric charges											
Insulators and conductors	3	3	3	5	3	3	3	3	3	5	34
Electrostatic induction											
Capacitors	0	0	0	3	0	0	0	0	0	0	3
CURRENT ELECTRICITY											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Production of an electric current, thermocouple, chemical, induction, etc.	0	3	0	3	0	0	0	3	0	0	9
Current flow, ohms law, units of current, voltage and resistance	0	0	0	5	0	0	0	0	0	3	8
Electric power	0	3	0	5	0	0	0	0	0	3	11
Laws of electrical resistance	0	0	0	3	0	0	0	0	0	0	3
Series and parallel configurations	0	3	0	5	3	0	0	0	0	3	14
Lenz's law, transformers	0	0	0	3	0	0	0	0	0	0	3
Chemical effects of electricity	0	0	0	3	3	0	0	0	0	0	6
Electrical resonance	0	0	0	3	0	0	0	0	0	0	3
Alternating current, inductive and capacitive reactance, impedance	0	0	0	5	0	0	0	0	0	0	5
ATOMIC ENERGY AND RADIATION											
Photoelectric effect											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Vacuum tubes and therionic effect	0	0	0	3	0	0	0	0	0	0	3
Conduction in gases	0	0	0	3	0	0	0	0	0	0	3
X-rays, production and properties	0	0	0	3	0	0	0	0	0	0	3
Structure of the nucleus											
Radioactivity											
CHEMICAL NATURE OF MATTER											
Atomic structure of matter	3	3	3	3	3	3	3	3	3	3	30
Physical properties	3	3	3	3	3	3	3	3	3	3	30
Chemical properties, valence, periodicity	3	0	3	0	0	3	3	3	3	0	18
Spectroscopy											
Law of fixed proportions											
Law of conservation of matter											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued Dependence of chemical change on energy change											
Oxidation and reduction											
Acids, bases and salts	3	3	3	3	3	3	3	3	3	3	30
Avogadro's law											
SOLUTIONS AND COLLOIDS											
Solubility and equilibrium dependence on heat, etc.	0	3	3	0	0	3	3	0	0	0	12
Colloids, nature and properties											
Ionization in solution											
ORGANIC CHEMISTRY											
Hydrocarbon compounds and other chain compounds											
Ring compounds											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued *BIOLOGICAL CHEMISTRY*											
Enzymes, hormones, vitamins											
PRINCIPLES OF EARTH SCIENCE											
General knowledges	0	3	0	0	0	0	0	0	0	0	3
Minerals											
Rock cycle											
Water cycle											
Atmosphere	0	3	0	0	3	0	0	0	3	0	9
Humidity	0	5	0	0	0	0	0	0	3	0	8
Weather and circulation of the atmosphere											
Weathering	0	3	0	0	0	0	0	0	3	0	6
Vulcanism Diastrophism, faults, etc.											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Principle of uniformitarianism											
Geologic time											
SKILLS ASSOCIATED WITH PHYSICAL SCIENCE											
Skill in measuring:	3	5	3	3	5	3	3	3	3	3	34
Distance	3	5	3	3	5	3	3	3	3	3	34
Rule	3	5	3	5	5	3	3	5	3	3	38
Vernier Caliper	0	3	0	0	3	0	0	0	0	0	6
Micrometer Caliper											
Crude range finder											
Dial indicator	0	3	0	0	0	0	0	0	0	0	3
Revolution counter											
Spherometer											
Associated skills:											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Eliminated parallax	0	3	0	0	3	0	0	0	0	0	6
Setting the zero	0	3	0	0	3	0	0	0	0	0	6
Estimating between scale marks	0	3	0	0	3	0	0	0	0	0	6
Weighing:	3	3	3	0	3	3	3	0	3	0	21
Spring balance	3	3	3	0	3	3	3	0	0	0	18
Platform balance											
Analytical balance											
Time:											
Spark timer use											
Oscilloscope											
Pressure:	3	3	0	0	3	3	0	5	3	3	23
Open and closed manometers											
Mercury barometer											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Temperature:	3	3	3	3	3	3	3	3	3	3	30
Thermometers and two major temperature scales											
Frequency:											
Revolution counter											
Oscilloscope											
Method of beats with a known frequency											
Electrical voltage measurement	0	3	0	5	3	0	0	0	0	3	14
Voltmeter	0	0	0	5	0	0	0	0	0	0	5
Vacuum tube voltmeter											
Potentiometer											
Electrical current measurement	0	3	0	5	3	0	0	0	0	3	14
Ammeter	0	0	0	5	0	0	0	0	0	0	5

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued Voltameter (electrical deposition of metal)											
Electrical resistance measurement	0	3	0	5	3	0	0	0	0	3	14
Voltameter-ammeter method	0	0	0	3	0	0	0	0	0	0	3
Ohmmeter	0	3	0	5	0	0	0	0	0	0	8
Wheatstone bridge											
Following technical directions:	3	5	3	5	5	3	3	5	3	3	38
Reading technical materials	3	5	3	5	5	3	3	3	0	3	33
Vocabulary	3	3	3	3	3	3	3	3	3	3	30
Recognition of priority in directions	3	5	3	5	5	3	3	5	3	3	38
Association of the physical reality with the written word or diagram	3	5	3	5	5	3	3	5	3	3	38
Ability to obtain information from graphs	0	5	0	5	5	0	0	3	0	3	21

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Organizing and tabulating information	0	3	0	3	3	0	0	3	0	0	12
Constructing technical materials	0	3	0	3	3	0	0	0	0	0	9
Tracing a wiring diagram	0	5	0	5	5	0	0	0	0	0	15
Soldering	0	3	0	5	3	0	0	5	0	5	21
Wiring a simple circuit	3	3	3	5	3	3	3	3	3	3	32
Keeping things operative	3	3	3	3	3	3	3	3	3	3	30
Chemically clean											
Care of delicate instruments	0	3	0	3	3	0	0	0	0	0	9
Care of optical equipment, lenses,etc	0	3	0	0	3	0	0	0	0	0	6
Knowledge of technical aids available for maintenance and repair of equipment	0	3	0	3	3	0	0	0	0	0	9
Experience enough to be able to recognize probable methods used in construction	0	3	0	3	3	0	0	3	0	0	12

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Chemical Safety	3	3	3	3	3	3	3	3	3	3	30
Poisons, solids, liquids and vapors	3	3	3	3	3	3	3	3	3	3	30
Chemical compatibility in storage	0	3	0	0	0	3	0	3	3	3	15
Chemical burns and fires	3	3	0	0	0	5	0	0	5	3	16
Protection of eyes and person	3	3	3	5	5	3	3	3	3	3	34
Disposal of chemical agents	0	3	0	0	3	3	0	3	3	0	15
Biological Safety											
Biological cleanliness, sterilization, pasteurization											
Toxic agents	3	3	3	3	3	5	3	3	3	3	32
Disease organisms											
Radiation damage	0	0	0	3	0	0	0	0	0	0	3
Disposal of Biological materials	0	0	0	0	0	0	0	3	0	0	3

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued Recognition of overuse of our environmental resources											
EARTH SCIENCE											
Identification of rocks and minerals											
Visual observation of land forms, recognition and ability to infer	0	3	0	0	0	0	0	0	0	0	3
Map reading	0	3	0	3	3	0	0	3	0	3	15
Ability to interpret sequence of events											
Three dimensional perception and visualization	3	5	3	5	5	3	3	5	3	5	40
Diagraming, sketching, sculpturing and expressing ideas by visual models.	3	5	3	3	5	3	3	5	3	5	38
Recognition of land form hazards, land slides, areas, faults, flood plains,etc.	0	3	0	0	0	0	0	0	0	0	3
BIOLOGICAL SCIENCE											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Observing fine detail	0	3	0	3	3	0	0	0	0	0	9
Using the microscope											
Sketching and interpreting drawings	3	5	3	5	5	3	3	5	3	5	40
Recognition of similarities and differences in the environment	0	3	0	0	0	0	0	0	0	0	3
Sterilization											
Ability to accomplish what might be distasteful tasks	0	0	0	0	0	0	0	3	0	0	3
PRINCIPLES OF THE BIOLOGICAL SCIENCES											
Energy, Matter and Life											
Conservation of energy and matter											
Life is energy dependent	0	3	0	3	3	0	0	0	0	0	9
Temperature dependence of life	0	3	0	3	3	0	0	3	0	3	12

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Energy cycle (photosynthesis, respiration)											
Chemical change as an energy source											
Composition between living things											
Protoplasm and cells											
Interrelationship between life and protoplasm											
Elements of protoplasm											
Parts of a cell											
Independence of cell size and organism size											
Mitosis and cell division											
Photosynthesis											
Metabolism, oxidation, respiration											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

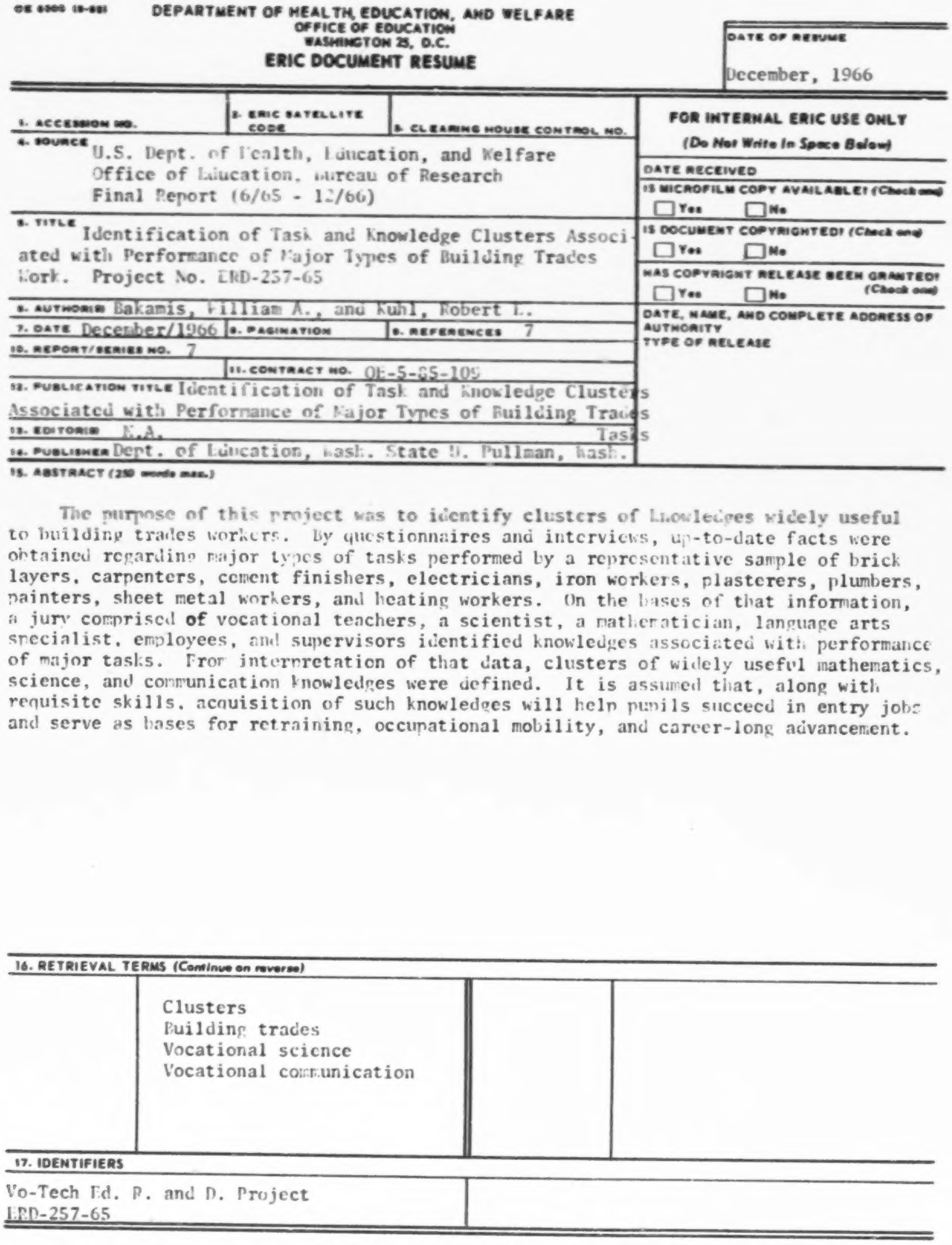
KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Diffusion of fluids	3	3	3	0	0	3	3	0	0	0	15
Osmosis											
Characteristics of living things, irritability, reproduction, growth, nutrition, excretion, etc.											
Morphology and Physiology											
Physical support and principles of movement	0	3	0	0	3	0	0	0	0	0	6
Materials for growth and replacement, digestion											
Circulation											
Disposal of wastes											
Stimulus and response											
Reproduction											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Embryonic Development											
Genetics and Heredity											
Chromosomes											
Genes											
Meiosis											
Mendel's Laws											
Modification of Species											
Continuity of life											
Evolution											
Mutation											
Adaptation											
Taxonomy											

KNOWLEDGES ASSOCIATED WITH WORK IN TEN BUILDING TRADES

KNOWLEDGES CODE: 5 - Operational 3 - Related 0 - Not essential	Bricklaying	Carpentry	Cement Finishing	Electrician	Ironworking	Painting	Plastering	Plumbing	Roofing	Sheet Metal (Heating-Air Conditioning)	TOTAL
Science continued											
Ecological Relationships											
Environment and Living Things	0	3	0	3	3	0	0	0	0	0	9
Life Necessities	0	3	0	3	3	0	0	0	0	0	9
Limiting Factors											
Interdependence											
Soil and Minerals											
Geographic Distribution											
Paleontology											
Fossils											
Succession of Fossils											
Applied Biology											
Diseases	3	3	3	3	3	3	3	3	3	3	30



OE 6000 [illegible] DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION
WASHINGTON 25, D.C.
ERIC DOCUMENT RESUME

DATE OF RESUME December, 1966

1. ACCESSION NO.
2. ERIC SATELLITE CODE
3. CLEARING HOUSE CONTROL NO.

4. SOURCE U.S. Dept. of Health, Education, and Welfare
Office of Education, Bureau of Research
Final Report (6/65 - 12/66)

5. TITLE Identification of Task and Knowledge Clusters Associated with Performance of Major Types of Building Trades Work. Project No. ERD-257-65

6. AUTHOR(S) Bakamis, William A., and Kuhl, Robert E.

7. DATE December/1966
8. PAGINATION
9. REFERENCES 7

10. REPORT/SERIES NO. 7

11. CONTRACT NO. OE-5-85-109

12. PUBLICATION TITLE Identification of Task and Knowledge Clusters Associated with Performance of Major Types of Building Trades Tasks

13. EDITOR(S) N.A.

14. PUBLISHER Dept. of Education, Wash. State U. Pullman, Wash.

FOR INTERNAL ERIC USE ONLY
(Do Not Write In Space Below)

DATE RECEIVED

IS MICROFILM COPY AVAILABLE? (Check one)
☐ Yes ☐ No

IS DOCUMENT COPYRIGHTED? (Check one)
☐ Yes ☐ No

HAS COPYRIGHT RELEASE BEEN GRANTED? (Check one)
☐ Yes ☐ No

DATE, NAME, AND COMPLETE ADDRESS OF AUTHORITY

TYPE OF RELEASE

15. ABSTRACT (250 words max.)

The purpose of this project was to identify clusters of knowledges widely useful to building trades workers. By questionnaires and interviews, up-to-date facts were obtained regarding major types of tasks performed by a representative sample of brick layers, carpenters, cement finishers, electricians, iron workers, plasterers, plumbers, painters, sheet metal workers, and heating workers. On the bases of that information, a jury comprised of vocational teachers, a scientist, a mathematician, language arts specialist, employees, and supervisors identified knowledges associated with performance of major tasks. From interpretation of that data, clusters of widely useful mathematics, science, and communication knowledges were defined. It is assumed that, along with requisite skills, acquisition of such knowledges will help pupils succeed in entry jobs and serve as bases for retraining, occupational mobility, and career-long advancement.

16. RETRIEVAL TERMS (Continue on reverse)

Clusters
Building trades
Vocational science
Vocational communication

17. IDENTIFIERS

Vo-Tech Ed. R. and D. Project
ERD-257-65

Figure 3. ERIC Document Resume

INSTRUCTIONS FOR COMPLETING ERIC DOCUMENT RESUME

The resume is to be used for storing summary data and information about each document acquired, processed, and stored within the ERIC system. In addition to serving as a permanent record of each document in the collection, the resume is also the primary means of dissemination. The upper left corner of the form (fields 1-14) is designed to conform to descriptive cataloging standards set forth by the Committee on Scientific and Technical Information (COSATI). Read the following instructions and complete the resume as directed.

A. GENERAL INSTRUCTIONS:

1. Read each entry point. If any point is not applicable, place "N.A." in the appropriate field. Except for those which you are instructed to leave blank, all fields must be completed with either the required information or "N.A."

2. Enter date of completion of the resume in space provided in upper right corner.

3. Entry must fit into space provided; if necessary use standardized abbreviation as cited by the American Psychological Association Publication Manual. (Publication Manual may be obtained from the American Psychological Association, Order Department, 1200 17th Street, NW., Washington, D.C. 20036.)

B. SPECIFIC INSTRUCTIONS:

Field 1. Accession No.: Leave blank. A permanent ED number will be assigned to each report and attendant documentation records as they are processed in the ERIC system.

Field 2. ERIC Satellite Code: Enter 3-digit code number assigned by ERIC to clearinghouse operation. If no code has been assigned, leave blank.

Field 3. Clearinghouse Control No.: If you are acting as a clearinghouse, enter the identifying number you have assigned to the document.

Field 4. Source: Enter corporate author, corporate source, or institutional affiliation of the author who originated the document. Include complete name and complete address of source, where possible. The Atomic Energy Commission Corporate Author, Entries, TID-5059 (6th Rev.) will be the authority for corporate source citations. (AEC Corporate Author Entries may be obtained from Clearinghouse for Federal Scientific and Technical Information, National Bureau of Standards, U.S. Department of Commerce, Springfield, Virginia.)

Field 5. Title: Enter full document title. If document comprises only a portion of the total publication or release, refer to field #12. Include subtitles if they add significantly to information in the title proper.

Enter volume numbers or part numbers, where applicable, as an added entry following the title.

If the document has been identified with a project number, enter the project number as an added entry following the volume or part numbers.

Include the type of report (whether proposal, in-progress, final, follow-up) as an added entry following the project number, where applicable. Following the type of report, enter the inclusive dates covered by the report, by month and year. (Example: 1/63 - 7/65.)

Field 6. Author(s): Enter personal author(s) (corporate author is entered in field #1), last name first. (Example: Doe, John.) If two authors are given, enter both. In the case of three or more authors, list only the principal author followed by "and others," or, if no principal author has been designated, the first author given followed by "and others." (Example: Doe, John and others.)

Field 7. Date: Enter date of release of document by month and year. (Example: 12/65.)

Field 8. Pagination: Enter total number of pages of document, including illustrations, appendices, etc. (Example: 115 p.)

Field 9. References: Enter number of references cited in the bibliography of the document. (Example: 406 ref.)

Field 10. Report/Series No.: Enter any unique number assigned to the document by the publisher or corporate source. (Example: OE-53015; LX-135.) Do not enter project numbers; these are added entries field #5.

Also enter journal citations by name of journal, volume number, and pagination. (Example: NAEB Journal, v. II, pp. 52-73.) Do not include date; date is entered in field #7.

Field 11. Contract No.: If document has been supported by the U.S. Office of Education, enter the OE contract number.

Field 12. Publication Title: If document abstracted comprises only a portion of the total publication or release, enter complete title of publication. (Examples: Four Case Studies of Programmed Instruction; The Automation of School Information Systems.) For journal titles, spell out any abbreviations. (Example: National Association of Educational Broadcasters Journal.)

Field 13. Editor(s): Enter editor(s) last name first. (Example: Doe, Mary.) If two editors are given, enter both. In the case of three or more editors, list only the principal editor followed by "and others," or, if no principal editor has been designated, the first editor given followed by "and others." (Example: Doe, Mary and others.)

Field 14. Publisher: Enter name and location (city and state of publisher.
(Example: McGraw-Hill, New York, New York.)

Field 15. Abstract: Enter abstract of document, with a maximum of 250 words.

Field 16. Retrieval Terms: Enter conceptually structurable terms which, taken as a group, adequately describe the content of the document. If terms do not fit into space provided on recto, use space allotted on verso for additional terms.

Codes: Leave blank. Codes will be assigned for internal retrieval purposes.

Field 17. Identifiers: Enter all terms which would not fit into a structured vocabulary. Examples are: trade names, equipment model names and numbers, organizations, project names (Project Headstart, Project English), code names, code numbers.

16. RETRIEVAL TERMS *(Continued)*

GPO 908-451